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Handling Malleable Castings

Methods Adopted in a Prominent Eastern Foundry, Including the Use of Lift Trucks and Raised Platforms Have Expedited the Work and Reduced Operating Expenses To a Material Extent

BY HERBERT R. SIMONDS

BECAUSE of the annealing operation, castings are handled twice as many times in a malleable iron foundry as in a jobbing gray iron foundry. This means that any loss suffered through inefficient means of handling is multiplied and also that greater opportunities are presented for making savings through a study of the material handling problem. After pouring, the castings are picked up from the foundry floor by forks, or by hand in the case of small castings, and by some form of hoist in the case of large castings. They then are placed on some form of conveyance and taken to the sandblast, the rattlers, or the pickling vats. This involves another handling from the conveyance to the cleaning device. In smaller foundries the common practice is to shovel the castings into the sandblast barrel, or the ordinary tumbling barrel, afterward to dump the contents of the barrel on the floor and then again shovel the castings into wheelbarrows or onto small trucks. From this point the castings are taken to the shipping department after which they are transported to the annealing room and packed into annealing pots.

All this means handling from the trimming bench to trucks or wheelbarrows, then the castings must be handled again

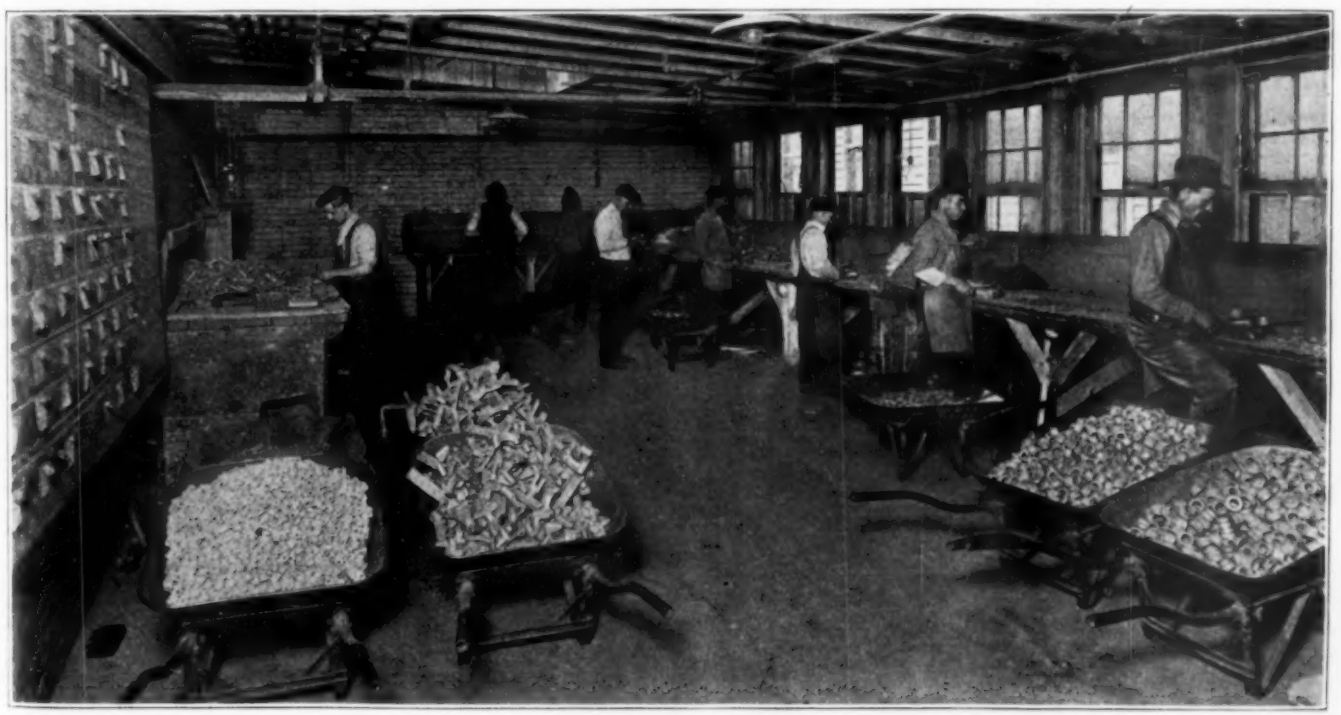

FIG. 1—IN THE OLD TRIMMING ROOM, WORK WAS DONE MOSTLY BY ARTIFICIAL LIGHT AND CASTINGS WERE LIFTED FROM WHEELBARROW TO WORK BENCH AND THEN REPLACED IN THE WHEELBARROW AFTER TRIMMING

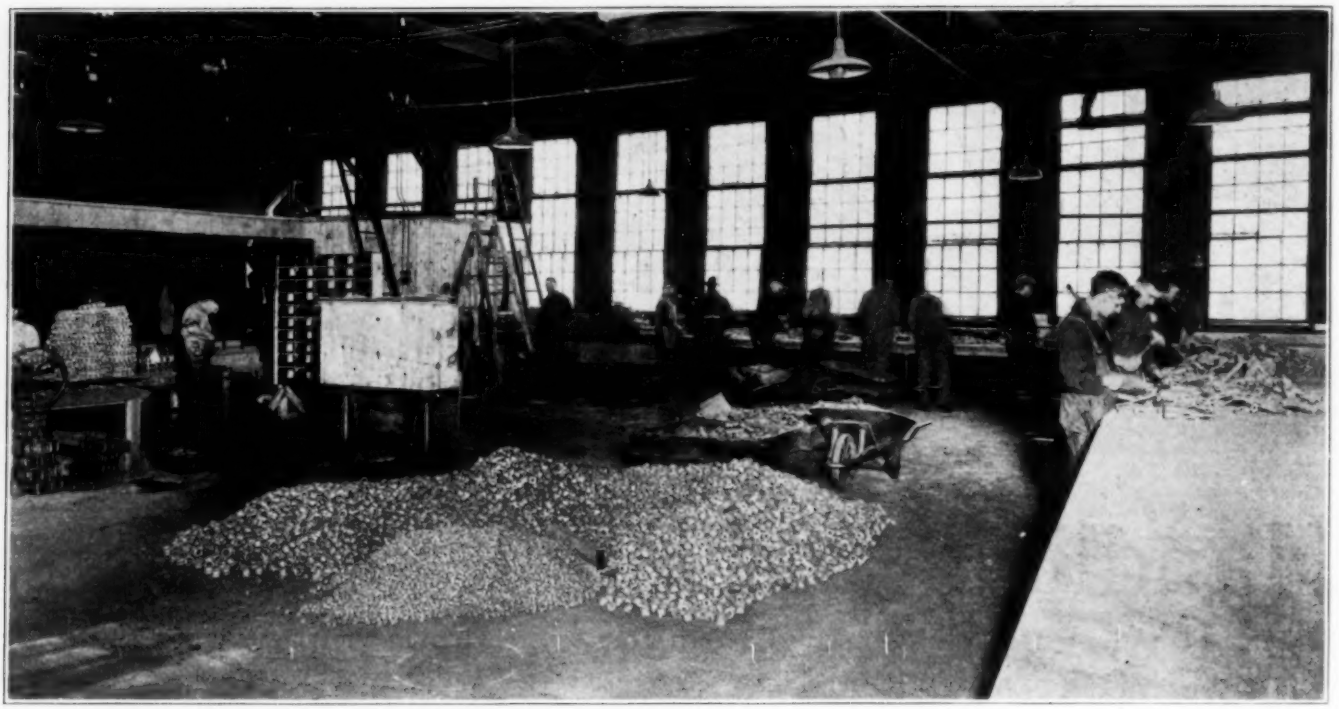

FIG. 2—IN THE NEW TRIMMING ROOM, CASTINGS ARE CARRIED UP AN INCLINE AND DUMPED ON THE BENCH DIRECTLY IN FRONT OF THE TRIMMERS—WORK IS ALL DONE BY DAYLIGHT AND THE WIDE BENCH GIVES AMPLE ROOM

from the trucks, or wheelbarrows, either onto the floor of the annealing room, or directly into the annealing pots. After they are annealed, the castings must be handled again. The contents of the annealing pots are knocked out on the annealing room floor and then the castings are picked up and placed in wheelbarrows and taken to the room known as the soft cleaning room. In this department the castings may be snagged, sandblasted or tumbled, according to requirements, after which they must be transported to the shipping room again and sorted, inspected, weighed and placed in bags or other containers ready for shipment.

From the foregoing outline of procedure in the average malleable foundry some idea may be gathered of the excessive opportunity presented for waste in handling materials. A manufacturer of standard products, involving a great deal of repetition work, might feel that the problem of handling material in a malleable foundry could be solved by the installation of belt conveyors, chutes and elevators. The problem faced by the manager of a jobbing malleable foundry is not of a character to be solved as easily as a cursory examination might seem to indicate.

Castings of all sizes and shapes constantly are passing through the plant and a system developed for one size and shape might become obsolete after two or three weeks' use, so far as the practice of the particular plant in question is concerned. At first thought it might appear that castings of different sizes could be sorted by screens or riddles, which would allow the small castings to drop through, but would retain large castings in much the same manner that gravel and sand are separated. A brief survey of the varied lines handled in a jobbing foundry, will show how impracticable this would be.

A considerable amount of manual labor probably always will be necessary in a jobbing foundry catering to many customers with a wide variety of requirements. However, hand operations may be eliminated in many foundries by rearranging departments and bestowing more careful attention on equipment and sequence of operations. Foundry equipment manufacturers realize the importance of simplifying handling and improvements in design continually are being made. Some of the methods employed to cut down handling to a minimum may be illustrated best by following through the normal sequence of operation in a jobbing malleable foundry.

Small castings on gates usually are separated from the sprue at the time they are picked up from the floor, by a man with a hammer. Because of the variety in size and style and the brittleness of the material, it is difficult to see how the hand operation here could be changed. In some plants the entire gate while still hot, is picked up by a hook and placed in a wheelbarrow. Before the hook is unfastened, the man with the hammer taps off the individual pieces, thus freeing the sprue, or gate which he still has on the hook and which he throws to one side as he stoops to pick up another gate of castings.

This method presents advantages and disadvantages. The man who does the collecting is required to lift the sprue to the level of the barrel and then throw it down again on the floor. If the gates were knocked off while the castings lay on the floor, the sprue would not have to be lifted. However, where eight, or ten, or more small pieces are to be broken off the gate, the time required to pick these small pieces up from the foundry floor, in case they are broken off first, is great enough to more than offset the work of lifting the sprue to the barrel level and then throwing it back on the floor in the manner first cited. Providing a sprue barrow close to the one used for the castings, is an improvement on the foregoing method. Instead of throwing gates on the floor they are transported from one barrow to another after the gates and castings have been separated.

Another method of collecting small castings is to use a large four-pronged fork to scoop the pieces up from the sand, just as they are cast. This usually means scooping up some sand with the castings and of course, it also means lifting the gates. To avoid carrying the sand from the molding floor into other departments, one foundry uses open mesh fire trays, supported on short legs. When the castings are scooped up and loaded into these trays, the sand falls through the screen and leaves the castings comparatively free from any sand.

After the castings have been picked up from the floor, they are transported to the trimming room. The common form of steel, foundry wheelbarrow is used a great deal for this purpose and

where castings are in small lots at different places on the molding floor and the distance to be carried not great, it probably is the most serviceable form of conveyance. In a jobbing foundry, taking all classes of work, the steel wheelbarrow probably never will be entirely displaced. However, where large quantities of castings are handled, mechanical methods of transportation may be adopted.

Small lift trucks, either gasoline or electric and a supply of trays of various sizes are employed extensively in conveying material in the foundry. Overhead trolleys and belt conveyors, often are used to advantage where the same material travels over the same routes day after day. This condition is not common in the foundry and therefore these means of conveying materials have not been widely adopted. One foundry using lift trucks claims that castings never touch the floor.

The molds are picked up bodily and dumped into open mesh trays standing on legs 10 or 12 inches above the floor. Most of the sand drops through the screen, and the castings, which in this case are relatively large, remain in the trays. When the trays are filled they are conveyed by an electric lift truck to the tumbling barrels. Under favorable conditions it is claimed the lift truck offers the most economical method of transporting castings, but conditions are not always favorable. To cut down overhead expense, the quantities of material handled must be sufficient to keep the truck busy throughout the day. The floors must be smooth and routes direct with a minimum number of turns. Cases where lift trucks prove most efficient usually are those where storage of articles in trays for short periods of time, is an important factor. This storage feature often eliminates the necessity of dumping material on the floor and picking it up again. After the castings are trimmed and sorted they are taken to the annealing room.

The problem of actually transporting the material is much the same as it was from the pouring floor to the trimming room, but once in the annealing room, new conditions present themselves. The castings must be packed in annealing pots. A common form of procedure is to run the castings into the department in steel barrels, dump the castings on the floor, place the first of a stack of annealing pots on a low stand, pick the castings from the floor by hand and pack them together with packing material, in the annealing pots, which are built up in tiers five or six high, and then pick up each individual tier with a special charging machine or a lift truck, and run it into the annealing oven. Difficulties incident to packing the top pots in the various tiers, probably have received less consideration than any other phase in the production of malleable iron castings. Packers still worry along with the use of intermediate platforms, step ladders and helpers. The great variety in size and shape of castings presents the chief difficulty in the way of adopting more efficient methods of packing.

In some cases hand packing of individual pieces is not necessary and small cranes may be used to lift the barrows so that the castings may be dumped directly into the upper pots. Where hand packing is necessary castings dumped into the annealing boxes are limited in number, and this usually means manual handling. In at least one eastern foundry, the problem of loading castings into the annealing pots, is solved in part by providing a raised platform to which castings are carried in trays by lift trucks. The operator stands on the platform while packing the upper tiers of annealing pots. One foundry superintendent proposes installing a small hydraulic elevator which might be raised as the pots were piled one on another, thus keeping the working level constant. The chief objection to this scheme is the initial cost and upkeep of the elevators. In even a moderate sized foundry 10 or 12 packers usually are working at once, which would entail the installation of an equal number of elevators.

After the castings have been annealed they usually are knocked out on the floor in the annealing department where the problem of picking them up and conveying them to the soft cleaning room practically is a duplication of the origin-

FIG. 3—IN THIS SHIPPING ROOM, OPERATIONS HAVE BEEN GREATLY REDUCED BY HANGING SHIPPING BAGS CLOSE TO THE SORTERS WHO THUS ARE ABLE TO SORT DIRECTLY INTO THE SACKS—HERE, AS IN FIG. 2, THE CASTINGS ARE CARRIED UP AN INCLINE ON TO THE BENCH AND DUMPED IN FRONT OF THE OPERATORS

al problem of removing the castings from the pouring floor. In the cleaning room itself usually there is ample opportunity for studying the handling of material and cutting down unnecessary operations. Tumbling and sandblast barrels may be arranged to dump automatically into wheelbarrows or truck trays. Snagging machines should be spaced far enough apart to permit storage in trays or barrows of the rough material on one side and the finished material on the other. After the last cleaning operation, the castings are taken to the shipping department for final sorting and shipping.

Some of the statements in the foregoing best may be illustrated by taking a specific case where the foundry manager has studied the handling problem and introduced new features which greatly cut down handling costs. The first change was made in the trimming room. The old trimming room shown in Fig. 1 was crowded and so dark that the operators had to work under artificial light most of the time and also the work constantly had to be lifted from the waiting barrows to the bench where the men worked. In the new trimming department, Fig. 2, adequate lighting facilities alone have increased production in this particular case by nearly 20 per cent.

However, the chief feature of the new room is the wide benches on which the men work. A runway leading to these benches makes it possible to dump the castings directly in front of the trimmers by trucks or barrows which are run up onto the bench itself. The sorted and trimmed castings from this department are thrown into waiting barrows, one size in each barrow, and then are ready to be taken to the annealing department.

In this same plant a little study resulted in changing an overcrowded shipping department into what is said to be one of the most efficient and well arranged shipping rooms in the jobbing malleable industry. A view of one corner of this room is shown in Fig. 3. The castings are run up on the work benches in the same manner as in the trimming room just described. Rows of hooks on which shipping bags are fastened are conveniently arranged back of the sorters. Each bag is hung on four hooks so that its top is spread wide open. The pieces are sorted directly into these bags, which, when full, easily are slipped off the hooks, tied and tagged and taken to the nearby motor trucks for shipment.

Because of the short distance to the trucks and the irregular periods when the bags become filled ready for shipping, hand trucks, similar to ordinary baggage trucks are used in moving the bags filled with castings. The proximity of the motor trucks to the shipping room was part of the general scheme of rearranging departments to cut down the distance traveled by castings. Fig. 4 shows the motor truck room, at one end of the shipping room shown in Fig. 3. A portion of the floor large enough conveniently to take two trucks has been lowered to a point that brings the floor of the truck approximately level with the plant floor. The trucks while loading are entirely within the building, a considerable advantage in cold weather. Another advantage of this arrangement is found in reduced loss of time due to trucks being in repair shops. The room is warm and conveniently arranged and small repairs therefore may be effected while the truck is in process of loading. Further improvement in the shipping arrangements in this particular foundry are in prospect. However, there is some danger of going too far along the line of providing material conveying equipment. The plant manager should be sure that the savings effected will at least pay interest on the investment.

Each plant has its own problems to solve and the correct handling of material in a jobbing malleable iron foundry can be achieved only through careful study of the prevailing sizes and kinds of castings produced. Make a layout of the foundry and then trace the movement of the castings from the time of pouring through every stage until they are shipped. If the line doubles back on itself, or is too irregular, it is safe to assume that there is needless travel at some point. Equipment should be kept busy and a partial solution of the problem of handling material may be found in increasing the load factor, or service time of handling equipment. One foundry manager installed small automatic recording instruments on his electric truck, which show the actual time each truck is in operation. According to analyses made in several plants, moving material from one point to another constitutes 50 per cent of the labor charge.

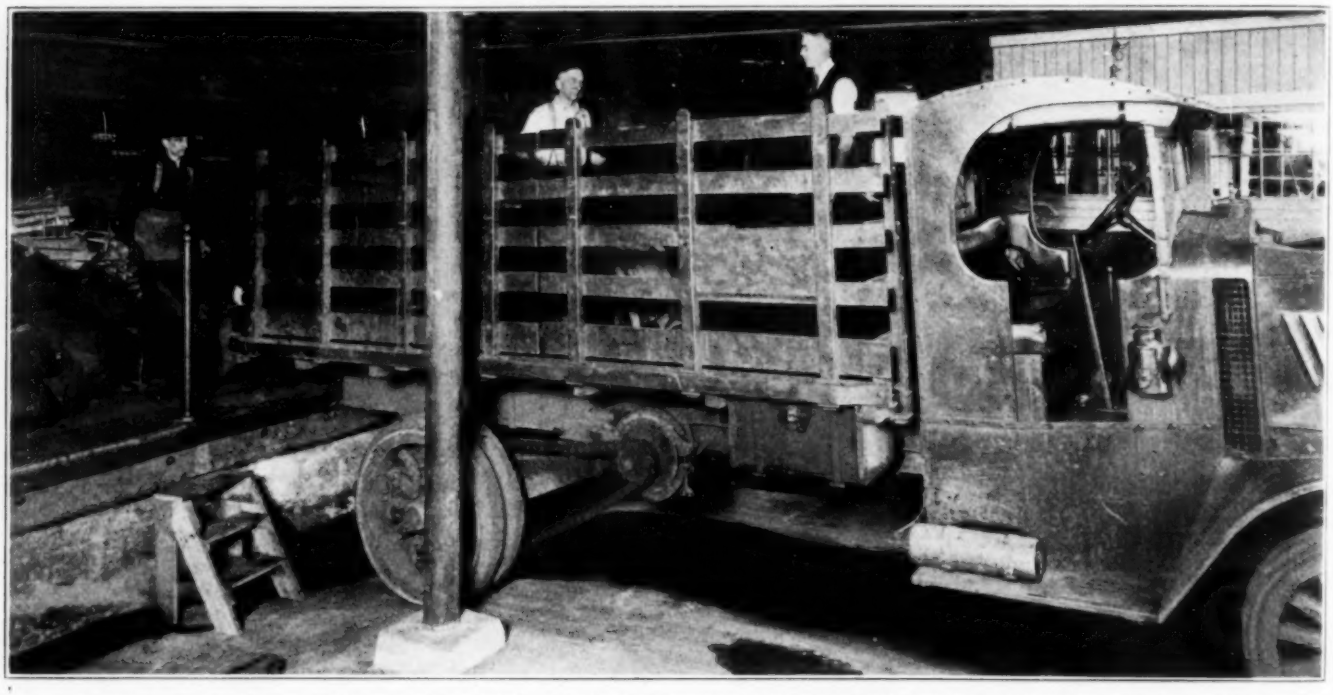

FIG. 4—SHIFTING SOME OF THE DEPARTMENTS MADE IT POSSIBLE TO RUN MOTOR TRUCKS IN CLOSE TO THE SHIPPING ROOM—BY DEPRESSING THE FLOOR THE LEVEL OF THE TRUCK BED WAS BROUGHT CLOSE TO THAT OF THE FOUNDRY FLOOR

Aluminum Melting Practice--I

Melting and Pouring Temperatures Should Be Kept Low—Effect of Different Types of Furnace on Oxidation and Occlusion of Gases Is Considered—Composition and Function of Drosses

BY ROBERT J. ANDERSON

NOT a great amount of study has been given the design of furnaces to be used especially for melting aluminum and its light alloys. The iron-pot furnace, which is really an adaptation of the soft-metal melting kettle, is the only furnace used for aluminum alloys which is not employed also for brass and bronze. Therefore, generally speaking, brass and aluminum alloys are, or have been, melted commercially in practically the same types of furnaces in foundry practice. The problems incident to the melting of aluminum and to light alloys are essentially peculiar in a number of marked particulars, and it is too much to expect that a furnace which is properly designed for operating on red brass will be equally suitable for melting No. 12 alloy.

It is common knowledge that good practice calls for heating the alloys only to the temperature required for getting the metal into the molds, and this is necessarily variable for depending upon the type of castings that are run. Roughly, the pouring temperatures for No. 12 alloy may be taken as between 650 and 880 degrees Cent. (1202 and 1600 degrees Fahr.), which covers the range for practically all commercial work. In heavy automotive work, i. e., oil pans and crankcases, 750 degrees Cent. is a quite common pouring temperature.

Requires Higher Melting Temperature

The melting temperature need not be more than 50 degrees and never more than 100 degrees Cent. higher than the pouring temperature to allow for any cooling that may take place during the transfer of metal from the furnace to the molds. In the case of aluminum-zinc, aluminum-copper-zinc, aluminum-magnesium, aluminum-copper-manganese, and other commercial light aluminum alloys, the same general principle holds true. The pouring temperature is governed quite directly by the melting point.

Some information derived from various published sources is given in the following paragraphs.

It is stated in many places in the trade journals that when aluminum or its alloys are melted they absorb nitrogen and other gases, and the chief difficulty in melting aluminum lies in overheating it.

Pyrometric Control

Collins* states that in melting aluminum alloys in foundry practice the metal should be heated to a temperature higher than is necessary to pour the castings allowing for a drop in temperature in dipping and transferring to the pots with which it is carried to the molding floor. A temperature of 1500 degrees Fahr. will usually take care of this. As soon as the metal is sufficiently hot, it should be thoroughly stirred, then dipped out, and carried to the molds. The metal in the furnace should be under pyrometric control and also should be kept covered during melting. Also, arrangements should be made for preheating the dipping and pouring ladles.

Schulz and Winkler* have discussed the melting losses resulting during the melting of some nonferrous alloys and say that, with reverberatory furnaces, the loss is naturally greater than in melting in crucibles, but the former system is preferred in many large works because of the larger output obtainable. Losses are highest when melting turnings and depend on the fineness and purity of the material. Moreover, there is great difficulty in separating the light molten aluminum from the floating slag. The more dusty material and dirt in the turnings and the more oxide adhering to them at the start, the greater the production of dross and, therefore, the loss of metal. The conditions are more favorable when domestic utensils or sheet aluminum are being melted down, the loss then rarely exceeding 5 per cent in the reverberatory furnace, provided the operation is properly managed. According to figures given by Schulz and Winkler an average loss of 21 per cent may be taken for remelting damp aluminum-alloy turnings in reverberatory furnaces, or 13.5 per cent of the dry weight of the charge.

It is clearly difficult to control the air and gas in a furnace so that the final products of combustion shall contain no free oxygen, and necessarily they must contain a considerable portion of nitrogen; and if, as in many furnaces, the gases are allowed to pass over the surface of the metal, oxidation may take place, and either nitrogen or carbon dioxide may be occluded in the metal.

If the products of combustion are prevented from coming in contact with the metal but air is admitted, then oxidation may take place and nitrogen may be absorbed. The possibility of melting under a vacuum upon a large scale is a doubtful commercial proposition, but it is probable that melting in special spots, which can be easily covered and thus protected from the hot gases and partially protected from the atmosphere, would reduce any risk of gas absorption and probably keep oxidation to a minmum. Certainly, the metal could more easily be kept free from dirt and rust. There may be a possibility of hydrogen being absorbed by decomposition of steam, or from other sources, during the manufacture of the virgin metal. Whether these gases can be eliminated is a matter for inquiry.

British Methods

The British Aluminum Co., Ltd., has given some information on the melting of aluminum alloys*. It is stated that the melting of aluminum is best carried out in a gas-fired furnace, using a mixture of gas and air adjusted so as to give a reducing atmosphere. No special precautions need be taken to prevent overheating, and burnt metal will not result even though the temperature be raised considerably above the melting point or the interval between melting and pouring be long.

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*Collins, J. W., Suggestions for making aluminum castings, THE FOUNDRY, vol. 42, 1914, pp. 67-68.

*Schulz, E. H. and Winkler, H., Waste in melting metals of alloys, The Metal Ind. (London), vol. 15, 1919, pp. 241-242; abst. from *Metall u. Erz*, vol. 16, 1919, pp. 215-218.

*Aron., Aluminum foundry practice, 1920, London, England.

With this type of furnace, the use of a flux is unnecessary. The process is a clean one and requires no stoking or carting of ashes. Heats are simply and easily controlled, and it is found that the labor cost is half that with a coke-fired furnace, and the total cost of melting is less than half.

Great Affinity for Oxygen

With the older types of furnaces, the danger of overheating must be carefully guarded against. Aluminum has an exceedingly great affinity for oxygen and at temperatures above the melting point oxidation takes place rapidly. The oxide formed is heavy and is occluded throughout the molten metal. If this occurs, satisfactory castings cannot be made. Moreover, like other metals aluminum in the molten condition absorbs gases which may cause blowholes in the castings. When melting in an ordinary coke-fired pit furnace, therefore, the temperature must never be allowed to rise much above the melting point, and it is a good plan to protect the surface of the melt by a flux of zinc chloride or cryolite. Whenever possible, plumbago or salamander crucibles should be used. Iron crucibles are often used because of their comparative cheapness, but this practice is not to be recommended, particularly with the aluminum-zinc alloys, since these alloys have a tendency to absorb iron. Overheating in itself is not injurious, provided that the metal is allowed to cool to the correct temperature before pouring, but it must be remembered that overheating an open type of furnace is generally accompanied by rapid oxidation and an absorption of nitrogen. This, of course, has a bad effect.

As a general rule, in the industrial operation of furnaces run on aluminum and aluminum alloys, the effort is made to keep the dross and oxidation losses as low as possible. However, some foundrymen prefer to have high metal losses for the sake of rapid melting, while others employ furnaces which are assumed to be inexpensive as to fuel consumption with the idea of keeping the melting costs low. In attempting to hold dross losses low, numerous factors involved in metal melting may be overlooked or at least disregarded, and the net practical result may be that the melting is exceedingly inefficient from the standpoint of fuel consumption. A cardinal rule in melting practice for aluminum and its light alloys is that the melting temperature should be kept low. The effect of increasing the temperature of melting, at least in an atmosphere containing free oxygen and nitrogen, is to increase the net melting loss.

If the efficiency of a melting furnace is to be determined, it is necessary to know the theoretical and actual amounts of fuel consumed in melting a unit weight of metal. In order to determine the theoretical amount of heat required to melt a unit weight of metal, it is necessary to have figures for the specific heat of the metal and its latent heat of fusion. Then assuming a given fuel or a definite calorific value, the quantity of fuel required can be calculated with accuracy. The furnace efficiency may then be considered as the quotient of

$$\frac{\text{theoretical amt. of fuel}}{\text{actual amount of fuel}} \times 100\%$$

Aluminum has a high specific heat and high latent heat of fusion; both values are considerably higher than those for brass and copper and the non-ferrous alloys in general. Hence, despite the fact that the melting point of 70:30 brass, for example, is much higher than that of the 92:8 aluminum-copper alloy, it requires about twice as much fuel to melt the latter. Some calculations will be made in a moment to show the amount of heat required to melt aluminum and its light alloys.

Specific Heat

The specific heat of a substance is the number of calories of heat required to raise one gram of the substance one degree in temperature, and it ordinarily refers to a rise in temperature from zero, unless otherwise stated. The specific heat varies with the temperature, and it is also closely related to the heat conductivity and to the linear and cubical expansion of substances. While the specific heat increases with temperature for the solid state, it appears to be practically constant for the liquid state.

No actual determinations for the specific heat of aluminum over the range 0 degrees Cent. to the melting point are available that may be relied upon. Without taking up the question of the specific heat of aluminum in detail, it is sufficient for the purpose of calculation to take the figures given by Richards* for the mean specific heat as:

$$Sm\ (0 - t) \text{ solid} = 0.2220 + 0.00005t.$$

This may be compared with $Sm\ (0 - t) = 0.0939 + 0.00001778t$ for solid copper.

The specific heat in the liquid state may be assumed to be constant. For aluminum, according to Pionchon, from the melting point to 800 degrees Cent.,

S in liquid state = 0.308.

For copper, S in liquid state = about 0.133.

Some calculations which have appeared in various published papers, purporting to show the amount of heat required to melt a unit weight of metal, have disregarded the latent heat of fusion. Such calculations are in error. The latent heat of fusion is numerical in character, representing the number of degrees Cent. through which one kilogram of water would be raised by one kilogram of the metal in passing from the liquid to the solid state. Richards has found that with the exception of aluminum, tin, and bismuth, the latent heat of fusion of one kilogram of metal is about one-third of the amount required to raise it from absolute zero (-273 degrees Cent.) to its melting point, or equal to 2.1 times its melting point (degrees Cent. absolute) divided by its atomic weight. The high latent heat of fusion of aluminum may explain the fact that the metal passes through a mushy, pasty stage before it becomes thoroughly fluid

The figures given for the latent heat of fusion of aluminum by different experimenters vary considerably. Glaser gives 76.8 large calories per kilogram or small calories (therms) per gram. Richards gives 90.9 calories. By calculation, i. e., if the latent heat of fusion is equal to 2.1 times the melting point (degrees Cent. absolute) divided by the atomic weight, the latent heat of fusion of aluminum would be 72.1 calories. These figures may be compared with 42 calories for copper. The value 76.8 calories are used in the following calculations. If the higher value of Richards, which may be more accurate, was used, higher figures for the amount of heat required to melt aluminum would be obtained. No figures for the latent heat of fusion of the common light aluminum alloys are available. Calculations to show the amount of heat required to melt and to superheat aluminum are given in Data Sheet No. 443, The Foundry, Sept. 1.

More Heat Required

So far as can be deduced from the available information, it is probably true that it requires less heat to melt the light alloys than it does to melt aluminum. It will be considered for the purposes of the present series of articles that it requires about 245 calories to raise one gram of aluminum or of the commercial light aluminum alloys to the melting point, and about 287 calories per gram or 517 B. t. u. per pound to superheat to 800 degrees

*Richards, J. W., Metallurgical calculations, part 1, McGraw-Hill Book Co., New York, 1915, p. 64.

Cent., as will be required for pouring ingots or pouring sand castings.

In aluminum and aluminum-alloy melting in fuel-fired furnaces, the question of the vaporization of metal is relatively unimportant. The total tonnage of zinc-containing aluminum alloys now made is relatively small, although there appears to be a decided interest in some aluminum-zinc and aluminum-copper zinc alloys. If zinc-containing aluminum alloys are made in large tonnages in the future, the question of zinc losses owing to the volatility of zinc, will be important as is the case with brasses. Vaporization of aluminum may occur in arc-type electric furnaces at the temperature of the electric arc and below.

Vaporization of Aluminum

The latent heat of vaporization of aluminum has not been determined, but it has been calculated by Richards* from the generalization that the latent heat of vaporization of atomic weight is proportional to the absolute temperature of the boiling point at atmospheric pressure and is numerically equal to about 23 times that temperature (21 times if the outer work of overcoming the atmospheric pressure be not included), i. e., by Trouton's rule. On the basis of an estimated boiling point of 2200 degrees Cent. for aluminum, the latent heat of vaporization (molecular) is 56,880 calories for an atomic weight of aluminum equal to 27, or 2,107 calories per kilogram, equivalent to 2,107 therms per gram. The molecules of a metal in the gaseous state are considered to consist of only one atom, i. e., the vapors of metals are monatomic. Data are not available for the boiling points of the common light aluminum alloys, but evidently they are less than for substantially pure aluminum.

The exertion of vapor tension is generally thought of in connection with liquids, and it is usual to speak of their normal boiling points as the temperature at which their vapors can exert a pressure of one atmosphere (760 mm. of mercury column). For liquid aluminum, this datum is not known with accuracy. Solid metals can also exert vapor tension, however, the vapor tension of the solid at the melting point being the same as that of the liquid. The vapor-tension curves for the solid and liquid states are not, on the other hand, prolongations of each other, since there is a cusp in the curve at the melting point. The vapor tension of the solid state is always less than the extrapolation of the curve for the liquid state below the melting point. The vapor-tension curve obtained by plotting the observed maximum vapor tensions against determined temperatures is not useful in the case of most metals, mainly because of an absence of data required for plotting, and secondarily because such curves are rather unmanageable. Further, they cannot be either interpolated or extrapolated accurately beyond observed points. Ramsey and Shields, however, have deduced from such curves that a nearly constant numerical relation subsists for any two given elements or compounds, between the absolute temperatures at which they have the same vapor tensions. The vapor tension of solid aluminum at 0 degrees Cent. is 5.25×10^{-7} from

$$\log. p = -\frac{13650}{T} + 8.4$$

where T is the absolute temperature. In the same way, the vapor tension of liquid aluminum at the melting point, 658 degrees Cent. is seen to be 1.0×10^{-43} from

$$\log. p. = -\frac{14190}{T} + 8.98$$

The volatility of aluminum is not an important factor in aluminum melting in the usual industrial types of fuel-fired furnaces, although it should be given attention in electric melting in arc-type furnaces. In dealing with the aluminum-zinc and aluminum-copper-zinc alloys, the volatility of zinc is a factor. Zinc boils at 930 degrees Cent., and the temperature of aluminum alloys melted in various types of furnaces may rise this high, although it should not exceed 800 degrees Cent.

Oxidation of Aluminum

Metallic aluminum is normally covered with a thin film of aluminum oxide, since the metal oxidizes in ordinary air at room temperatures. When heated in air at temperatures up to the melting point, small particles of aluminum gradually go over to aluminum oxide, despite the supposed protective effect of the surface film. Some uncertainty exists as to the actual final end product of the oxidation of aluminum, and it is only possible to present here the available views rather than give experimental evidence in favor of one or another.

Briefly, when aluminum combines with oxygen the end product is generally considered to be the oxide Al_2O_3, according to the reaction

$$2\ Al + 3O = Al_2O_3.$$

Superficially examined, the oxidation of aluminum therefore appears to be entirely elementary in character, but there is sufficient experimental evidence to show that it is one of the most difficult problems to be dealt with in the melting of aluminum and its light alloys. In ordinary air, the oxidation of aluminum may be regarded rather more as an hydration of the metal taking place simultaneously with oxidation, since in the presence of water, the reaction

$$Al + 3H_2O = Al(OH)_3 + 3H$$

takes place, and a colloidal film of aluminum hydroxide is formed. In the presence of carbon dioxide, such as in moist air containing that gas, oxidation of the metal takes on a pitting effect, owing to the attack of carbon dioxide on the film of aluminum oxide and aluminum hydroxide, thus exposing fresh surfaces of metal to further action. Aluminum oxidizes rapidly if the surface is rubbed with mercury, an arborescent growth of aluminum oxide forming quickly all over the metal. This phenomenon has been described by a number of workers. McClendon* states that aluminum will burn rapidly in air (humidity 10 per cent at 20 degrees Cent.) if a trace of mercury is driven into it by an electric spark. The white oxide is formed so rapidly that it appears "to grow out of the metal as plants grow out of the ground, attaining the heighth of a millimeter in a few minutes." When aluminum is oxidized by rubbing it with mercury in the air, considerable heat is developed.

Aluminum Dross

Reverting to the oxidation of aluminum and its light alloys on melting in industrial furnaces, it may be said briefly that the metal is readily oxidized in the presence of air, and rapidly at elevated temperatures, with the formation of oxides of aluminum. More specifically, it should be said that the rate of oxidation is a function of the temperature, and is dependent upon other specific conditions. The annual monetary losses in the United States because of oxidation during melting aluminum are about $3,000,000, and one of the important problems before the industry today is the prevention of oxidation during melting. Aluminum dross is usually regarded as consisting of aluminum oxide, (Al_2O_3), plus metallic aluminum. There is a good deal of evidence in the literature and elsewhere that oxides, other than the sesqui-oxide, (Al_2O_3), may exist. The existence of

Richards, J. W., The vapor tensions of the metals, Jour. Franklin Inst., vol. 187, 1919, pp. 591-598.

McClendon, J. F., Acceleration of oxidation of aluminum by means of mercury, Univ. of Minn. Biochem. Bull., vol. 4, 1915, p. 96.

certain sub oxides of aluminum has been suspected by a number of investigators at various times as far back as 1870.

In actual foundry practice it will be found advantageous to pay attention to the following: The protective coating of aluminum oxide which covers aluminum has been mentioned; its protective effects have been affirmed by some, but denied by others. Obviously, if an unbroken film of aluminum oxide with a melting point of about 2050 degrees Cent., covers a piece of aluminum, it will offer some protection against the effects of both heat and oxygen. If the film is broken, then oxidation occurs at the break. It has been found in furnace practice, especially in reverberatory furnaces, that the gross melting loss will be less if a layer of dross is kept on the surface of the bath so as to protect the aluminum from contact with free oxygen in the furnace atmosphere. Rhodin* states that high percentages of aluminum oxide in aluminum are associated with high percentages of iron, and that metal with 0.3 per cent aluminum oxide is obtained from a reverberatory furnace, as against 1.5 per cent and more aluminum oxide in metal melted in iron-pot furnaces. The reason for this is not clear.

Amount of Oxidation

Turning in particular to the melting of aluminum and its light alloys, with the intention of holding the oxidation losses low, it is evident that the total oxidation will always be increased when fresh surfaces of liquid metal are exposed to air, or to free oxygen in furnace atmosphere; therefore, the bath should be stirred only when necessary, and care should be taken not to break the surface film more frequently than is required. In the case of iron-pot furnaces, the atmosphere in contact with the metal is practically unaltered air, and some advantage is gained in operating these furnaces with closed covers so as to hold air circulation to a minimum. In all types of crucible, pit, and open-flame furnaces the amount of oxidation is largely dependent upon the quantity of free oxygen in the furnace atmosphere. When these furnaces are run with a large excess of air, oxidation losses should be expected to be greater than where combustion of the fuel is more nearly perfect, i. e., where only a small excess of air over that required for combustion is supplied.

In melting practice, the aluminum oxide formed is often thought to be lighter than aluminum, since it floats on the top of the bath. However, the specific gravity of aluminum oxide (Al_2O_3), is considerably greater than that of aluminum and most of its light alloys, and the general tendency, from the standpoint of specific gravity alone, would be for the oxide so formed to sink to the bottom of the bath. The fact that some of the oxide does sink is shown by reverberatory furnace practice in melting substantially pure aluminum, where a fairly large accumulation of oxide builds up on the furnace bottom after a few days of continuous melting, requiring removal by scraping. It should be stated here that if aluminum oxide is not wetted by liquid aluminum, it will float; if it is wetted, the specific gravities and surface tensions must be taken into account. The specific gravity of liquid aluminum at 800 degrees Cent. may be taken as 2.34, while that of its amorphous oxide is 3.85. Obviously, when the oxide is wetted by aluminum it will sink to the bottom of the bath. The explanation of why a surface covering of dross is always found over the top of a bath of liquid aluminum must be sought in a consideration of the surface tension of liquid metals.

The work of Worthington* and his demonstration of the reality of the increase in density at the surfaces of liquids is of the greatest interest. No figures are available for the specific gravity of liquid aluminum at the surface as compared with the interior of a bath, but both the viscosity of aluminum and its surface tension will assist in maintaining an oxide scum on the surface. The surface tension of liquid aluminum in the range of 700 to 820 degrees Cent. is given by Smith* as 520 degrees per centimeter.

Much uncertainty exists as to the chemical constitution of aluminum drosses. Roughly, dross is generally considered to consist of aluminum oxide (Al_2O_3), plus metallic aluminum mechanically entangled therewith. Evidently, however, aluminum drosses are variable as to chemical composition, and it is probable that part of the aluminum oxide of dross may be some oxide other than Al_2O_3, and possibly a mixture of such oxides. Not much attention has been paid to the nitrogen content of aluminum dross, but nitrogen is ordinarily present in most drosses as aluminum nitride, AlN, in varying percentages. The amount of metallic aluminum in dross may be variable—from say 5 to 60 per cent, or more or less depending upon the origin of the dross.

A distinction is necessary between the dross skimmed from heats of substantially pure aluminum and that skimmed from heats of light aluminum alloys. The latter usually contains metallic oxides, other than aluminum oxide, depending upon the alloy melted. Not many published analyses have appeared giving the constitution of aluminum dross, and most of those given appear to be quite incomplete. Several methods have been devised and published for the analysis of dross, but unfortunately no details of the method to be used for sampling are ever supplied. It is evident that if a representative sample cannot be secured—and this is practically impossible for aluminum dross because of its physical characteristics—there is not much use in detailing methods of analysis.

Melting Dross

No smelter of secondary aluminiferous materials could possibly remain in business if the attempt were made to buy drosses on the basis of chemical analysis, for the obvious reason that a representative sample which can be subdivided later for chemical analysis cannot be obtained. In the purchase of such drosses by smelters and refiners, the materials are bought on the basis of a fire assay, i. e., a miniature smelting run on a representative sample of sufficient size. The size of the sample may, and should, be from 5 to 25 pounds of dross. The recovery obtained after smelting, according to a prescribed code which varies with different smelters, is the basis of payment. The recovery of aluminum from dross normally consists in a remelting process by which the aluminum oxide and other materials are separated from the metal.

Some methods for the chemical analysis of aluminum dross have appeared in the literature, of which the ones by Bessenberger* and by Hiller* may be mentioned. A typical analysis of an aluminum dross slagged off from the ordinary melting operation on light alloy may be cited. The material was first sieved to remove any metallic aluminum. As received, the sample contained 6.82 per cent volatile

Private communication, J. G. A. Rhodin, May 26, 1920.

Worthington, A. M., On the surface forces in fluids, London, Edinburgh, and Dublin Phil. Mag., vol. 18 (fifth series), 1884, pp. 334-364.

Smith, S. W. The surface tension of molten metals, Jour. Inst. of Metals, vol. 12, 1914, pp. 168-213.

Bezzenberger, F. K., The evaluation of aluminum dross, Jour. Ind. and Eng. Chem., vol. 12, 1920, pp. 78-79.

Hiller, H., Uber die Analyse von Aluminiumasche, Zeit. fur angew. Chem., vol. 33, 1920, pp. 35-36.

matter. On the dried sample, the following analysis was obtained:

	Per Cent
Silica	14.23
Copper oxide	4.47
Iron oxide	13.43
Zinc oxide	3.04
Aluminum oxide	64.70
Total	99.87

The nitrogen content in this sample was not determined, but a separate determination is required for this because when a dross sample is placed in contact with water the nitrogen is evolved as ammonia.

Nitrogen combines directly with aluminum at moderate temperatures to form aluminum nitride, AlN, and the fact that aluminum drosses contain aluminum nitride is well known.

Ample evidence of the presence of aluminum nitride in ordinary dross is attested to by chemical analysis—the ammonia evolved on treatment with water may be determined quantitatively. The odor of escaping ammonia which may prevail in the neighborhood of weathering dross piles is often pronounced especially after a rainfall. It is true that if a pile of dross commences to *burn* that additional aluminum nitride will be formed, by direct reaction with the nitrogen of the air, as well as aluminum oxide, but if dross is skimmed from an aluminum melt, after cooling or not, and treated with water, ammonia will be given off. In the presence of moisture, aluminum nitride gives rise to aluminum oxide and ammonia, according to

$$2AlN + 3H_2O = Al_2O_3 + 2NH_3$$

The effect of nitrogen in dross formation is important, but this appears to have been imperfectly considered in aluminum and aluminum-alloy melting practice. In melting practice, part of the metal loss is caused by the formation of aluminum nitride through the interaction of aluminum and nitrogen at ordinary melting temperatures. Since both oxygen and nitrogen are present in practically all furnace atmospheres, the melting loss will be a function of the constitution of the furnace atmosphere and the melting temperature, among other factors. The oxygen content of some furnace atmospheres may be low, but the nitrogen content of practically all furnace atmospheres is generally high.

Considerable divergence of opinion exists as to the mode of occurrence of nitrogen in aluminum, i. e., as to whether it is included as elemental nitrogen, occluded as aluminum nitride, or in solid solution as aluminum nitride nothing has been established.

Study of Sands for Foundry Use Pays

BY FERDINAND G. SHULTZ

SAND is used in the foundry for molds for sandblasting, and as a refractory, and is quite an item of expense. Often molding sand is brought from long distances when a satisfactory grade of sand could be obtained from local sources at a lower cost if the actual requirements and the blending of sands were understood thoroughly.

In using sand for steel casting work, two foundrymen making the same grade of work will seldom agree on the same sands. Here is a large field open for research work. Chemical analysis will determine the amount of bond, and the nature of the bond contained in the sand. Microscopic tests will show the shapes of the grains. But, where can be found a foundryman, who after being told the composition of a certain sand, is in position to guarantee its bonding properties. However, it seems that the foundries making heavy steel castings strive to obtain a sand fairly high in silica, high in fusion, and with a large open grain. The foundries making the smaller steel castings use a sand less coarse. Some steel sands have a natural bond, thus reducing the addition of fireclay, molasses water and other items of expense, but no standard has been adopted.

In the iron foundry, with the exception of those making heavy castings, the margin of safety in sand is an element not given much consideration. Few scrap castings result from improper use of sand for this grade of work. For floor work, small castings, the coarser grades of Albany sands still are used as standard in the East, and as the work gets heavier, coarser sands from local deposits are the rule. Sometimes these are mixed with the Albany grade to get the consistency desired.

Fine Sand for Sandblasting

For cleaning castings by sandblasting a fine sand of unusual uniformity, a flint-like structure seems to give superior results, no doubt due to its ability to stand up under the terrific impact when leaving the air hose. Little change of confusion in the trade exists when selecting sand for this particular use, inasmuch as trial tests are so simple and results so readily apparent, that the foundryman has slight difficulty in selecting a material adaptable to his use. Cleaning castings by special sands not only leaves an aluminum-like surface in appearance, but it also shows up defective castings, by exposing such defects that may be near the surface.

Silica sand is the chief material used in the making of the acid open-hearth furnace bottom. Several years ago a Pennsylvania steel company made chemical and practical tests of sands it was using, in making bottoms. It experimented with two sands, one from Ohio and the other from Pennsylvania. The analysis of both sands were practically the same, with only extremely slight variations. In this particular case a certain Pennsylvania sand gave the better results on account of the physical condition. The best results in the open hearth are obtained from a sand of a flaky nature. Sand of a soft granular nature when ground and put through a screen, is entirely too fine. When the furnace is heated, such sand will run to the bottom, due to having a lower fusing point, and after two or three heats will flake off in large cakes.

The American Foundrymen's association is becoming more active in the work of establishing standards for sands. On Dec. 9, 1921, a molding sand committee, organized under the auspices of the National Research council and the American Foundrymen's association, held its first meeting in New York. That the results of this activity will be far reaching cannot be disputed. But, it is essential that support be given this work by the local foundrymen's associations, and their individual members.

Operate Massachusetts Gray Iron Foundry

J. P. Murphy and D. J. Lynch recently have taken over the plant of the Northampton Iron Works, Florence, Mass., formerly operated by E. W. Murphy. The new firm will manufacture gray-iron castings. Mr. Lynch was previously connected for a period of 10 years with the Norwood Engineering Co., Florence. Mr. Murphy has been associated for 12 years with the Northampton Iron Works of the same city.

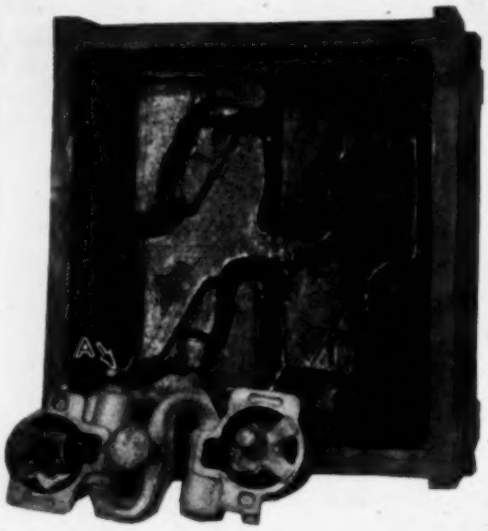

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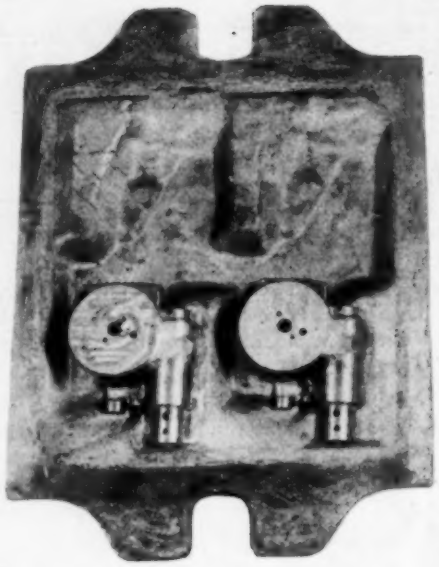
FIG. 1—COREBOX FOR MAKING THE CORE WHICH RAMMED IN THE DRAG FORMS THE FACE OF THE PLATE FIG. 2—GATED CASTINGS FIG. 3—COPE SIDE OF THE PLATE FIG. 4—DRAG SIDE OF PLATE WITH PATTERNS FIG. 5—FRAME FIG. 6—CASTING HELD IN DIVIDING HEAD



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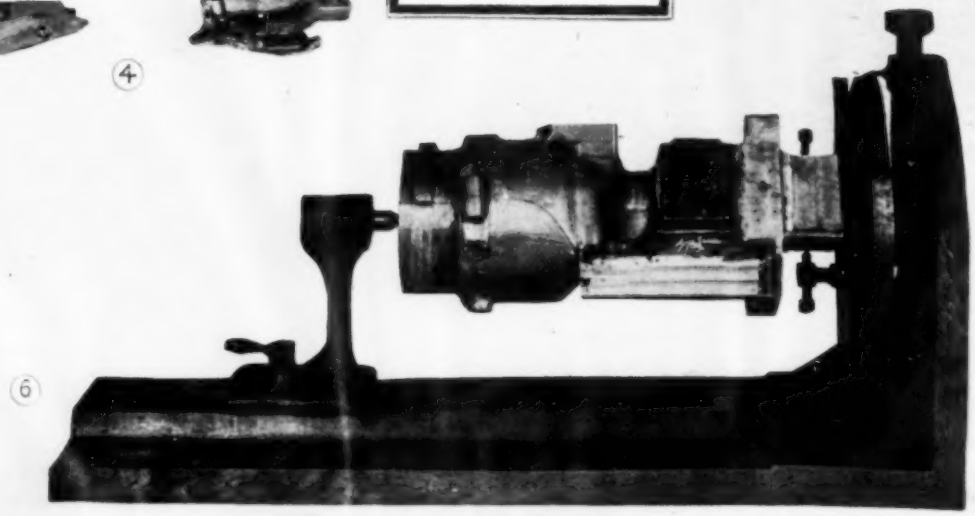

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Firm Demands Pattern Accuracy

Drag of Mold for Pattern Plate Made of a Core Bedded in Sand To Ram Cope Against—Dividing Head Serves in Determining Centers on Patterns—Corebox Parts Fit Only One Way

BY H. E. DILLER

ONE of the first questions which presents itself in preparing for the production of almost any new product is how much care should be taken in its manufacture. If too much labor is expended in needless small particulars, an unduly high production cost follows, while if a product is made which does not fully answer the requirements, money is lost on replacements. An example of the former condition was noted where a manufacturer of pipe fittings sent an expert to study production methods of founders in a different section. The expert came back with recommendations which meant a considerable saving in production cost but at the expense of the appearance of the product. As the manufacturer had prided himself on the finish of his castings, it was long before he could be convinced that a change in the finish of the castings, which would not detract any from their usefulness or from their appearance when painted and in use, would be warranted, even at the considerable saving in production costs.

Possibly the other extreme is the manufacture of patterns for intricate articles which must be within close limits as to dimensions. Here a slight variation may make endless trouble in the machine shop, or a wrong gate may cause castings to crack or become dirty when poured in the foundry. In such cases all expenditures which make for accuracy in the pattern will be amply repaid by a low percentage of scrap in the foundry and expense avoided in the machine shop. Of course, the amount of care which is justified must be decided by the kind of castings to be made from the patterns. No care is too great in making castings for automobile starting and lighting sets according to the judgment of the Dayton Engineering Laboratories Co., Dayton, O., which manufactures this type of equipment for many makes of automobiles. Therefore, the methods of this company are interesting from the standpoint of accuracy of workmanship.

Shop Well Equipped

The pattern shop, located on the second floor of one of the older buildings of the group housing the shops of the Laboratories company, contains 20 benches for metal workers and 18 for wood workers. The proportionately large number of wood workers are needed because, although practically all the patterns for production are made of metal, all the master patterns and patterns for castings for experimental work are made from wood. The metal section is fully equipped with engine lathes, vertical mills, universal mills, drill presses and grinders, while the woodworking department is supplied with rip saws, planers, sanders and the minor equipment needed in such work, such as electric soldering furnaces for heating irons, etc.

While the company has its own aluminum and brass foundries it has its gray-iron, malleable-iron and steel castings made in jobbing foundries. Thus, it becomes necessary for general foreman of the pattern shop, W. J. Schneider, to keep in touch with a number of foundries and to furnish them with suitable pattern equipment. To maintain his control and prevent a large production of castings being made off an incorrect pattern, Mr. Schneider insists that sample castings must be made and have to be approved before any new pattern is put into production. When a sample casting is received by the pattern shop, it is machined the same as it would be in the machine shop except that it is not fitted to jigs. Then it is carefully gaged to determine whether all centers are in lines. All centers are scribed as the pattern would be incorrect if any one was off, no matter if all the others were correct. In case any portion of the pattern is not true, it is corrected and new samples are requested from the foundry.

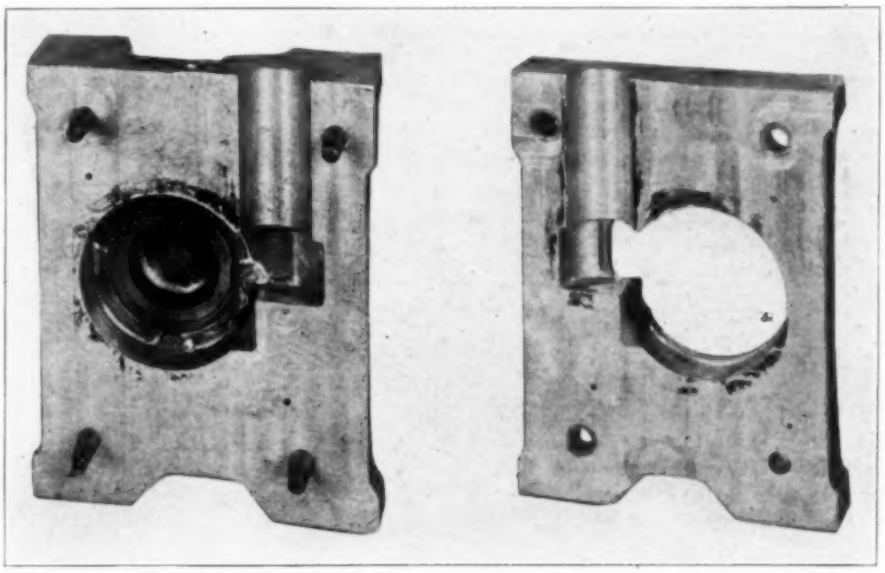


FIG. 7—DOWEL PINS IN CORE BOXES ARE SPACED IRREGULARLY SO THE PARTS CAN BE PUT TOGETHER IN ONLY ONE WAY

The dividing head used for determining the centers on a pattern is shown in Fig. 6. The frame of this mechanism is a gray-iron casting with the outside surfaces machined true and at a right angle with each other. The one side of this casting supports a head which turns on a bearing in the casting. Two set screws, fitted with supports on a steel rod attached in a fixed position of the head, serve to hold one end of the pattern. The supports slide on the steel rod and are fastened to it by set screws. The other end of the pattern is supported by a centering pin on a standard which slides along a groove in the other side of the frame casting.

Castings Held in Dividing Head

The casting shown in the dividing head is a distributor housing for a starting set on the Lincoln automobile. It is painted with black shellac at the places where centers are to be located. With the dividing head on a surface plate it is easy to make measurements with a surface gage, scratching a mark with the point of the gage. The design of the head is such that it can be stood on any one of the planes and bein a position at right angles or parallel to the other

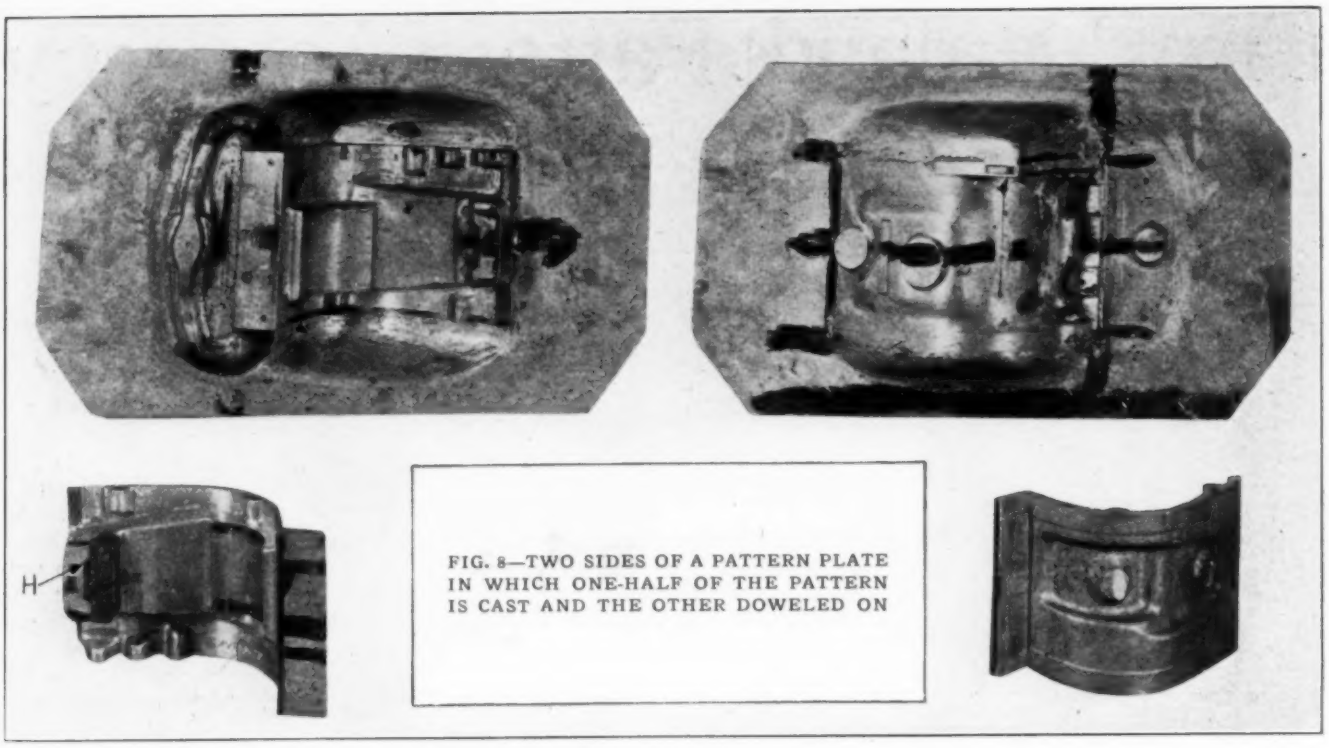


FIG. 8—TWO SIDES OF A PATTERN PLATE IN WHICH ONE-HALF OF THE PATTERN IS CAST AND THE OTHER DOWELED ON

planes. Thus, from the position in which it is shown in Fig. 6, it may be tilted back to the right, or to either side. If it is desired to turn the pattern at some angle other than a right angle this can be done by turning the knob shown at the top to the left. This releases the shaft of the revolving head and allows it to turn to any desired angle which is measured by the pointer at the top. This indicates the angle marked off on the rim of the revolving head.

Possibly the best way to get an idea of the methods used in the shop is to follow through the production of a representative pattern. For this purpose the distributor housing for the Buick automobile has been selected. Three views of the gated casting, which is made of gray iron, may be seen in Figs. 1 and 2. To make this casting requires an irregular parting which precludes the use of a flat plate. Therefore, the first difficulty comes in making the plate. Instead of ramming up one section of the mold and ramming the other section on top of this, a corebox is made which gives the desired outline of the plate. The split patterns described later are used for obtaining the correct contour of the wooden corebox. This corebox is shown in Fig. 1 and illustrates one of the needs for the wood worker in this shop.

After the corebox is completed, a core is made and dried. This then forms the basis for the drag. It is laid face down on a board which has a square cut out large enough so that the irregular section of the core does not touch the board which supports all the edges of the core. A flask then is set around the core and molding sand is tucked on all sides and on top of it. After this sand has been rammed and struck off a bottom board is placed on the flask and the whole is turned over. The face is then slicked and serves as a solid foundation for ramming the cope. After the cope

FIG. 9—VIEWS OF A CORE BOX OPEN AND CLOSED AND THE CORE DRIER—NOTE THE METHOD OF CLAMPING AT *B*—DOWEL PINS ARE ATTACHED TO THE LOOSE PIECES SO THAT THE BOX CANNOT BE CLOSED UNTIL ALL THE LOOSE PIECES ARE IN PLACE

is rammed and taken off a wooden frame. Fig. 5, is set on the drag around the outline of the core. A strip also is set on the flask and sand is tucked between the frame and the strip, and struck off level. The frame and the strip both being the exact thickness it is desired to make the plate, when the frame is taken away the strip and the sand which has been rammed between the frame and the strip allow the cope to be closed only far enough so that when metal is poured into the mold a plate will be formed the size and thickness of the frame and with the outline of the core on the one side and its complement on the other. The frame is poured from a down gate and two runners at each end.

To produce the pattern for the pattern castings, a master pattern is made of wood in two sections, one for the cope and one for the drag part, according to the line of parting. Four pattern castings are made from each, No. 12 alloy being used for the castings as well as for the plate. These castings are then dowled and screwed together, after which they are machined all over and measured for centers. One of these castings is illustrated at the bottom of Fig. 3. Above on the plate in the same illustration may be seen the cope half of the pattern, while Fig. 4 shows two of the drag sections of the pattern on the plate, and two of the cope sections laying at the bottom. The plate is carefully filed until the pattern section fits it exactly. Each section of the plate is numbered and every piece of pattern is stamped with a number corresponding to the number of the section of the plate where it fits. The pattern is taken apart and one half of it is placed on the plate and holes are drilled through the plate using the holes in the pattern as a guide. The other half of the pattern then must be located so that the holes in it are exactly opposite to the holes is the first section, and dowels must be fitted through the holes in one section and extending through the plate must coincide with the holes in the other section.

Put Together in One Way Only

The one core for the casting is made in the aluminum corebox shown in Fig. 7. It may be noted that the dowels are not regularly spaced. This is done so that the box can be put together in only one way, and that the right way. In ramming the sand in the corebox, the metal around the lower ring which forms the print gets worn badly. When this wear passes the allowable limit of variations for the core, the box is machined at the lower ring and a steel ring is inserted. This lasts much longer than the original aluminum alloy which was part of the corebox casting. The life of the corebox also is increased by setting steel

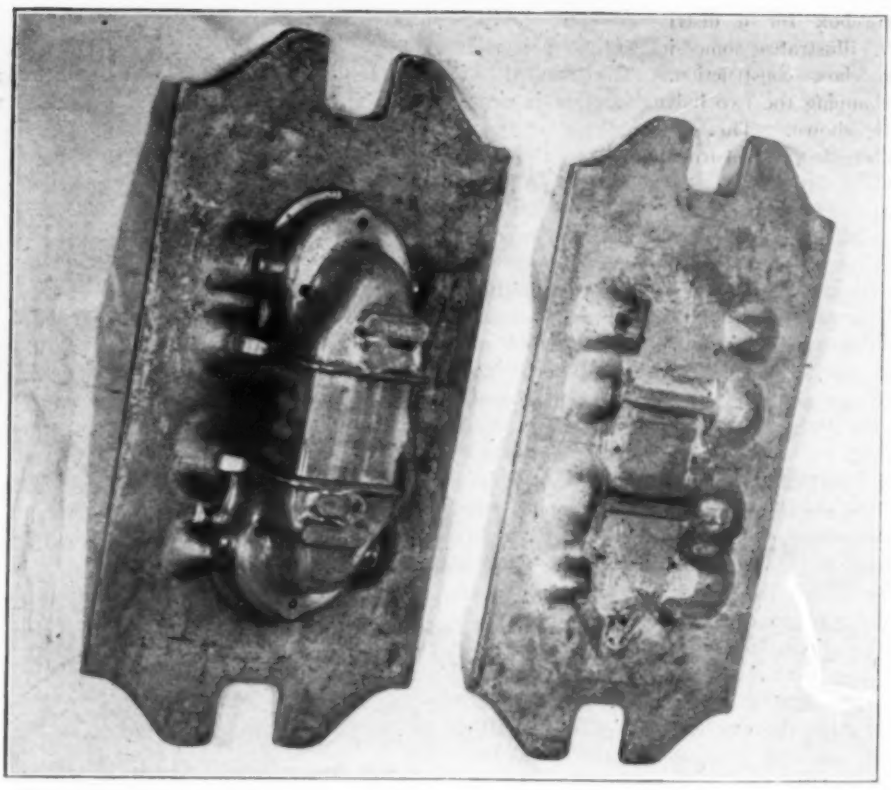


FIG. 10—TWO SIDES OF A PLATE FOR A COVER CASTING WITH A DEEP DRAW

bushings in the dowel pinholes and making the pins of steel. This core is supported in the mold by the print in the drag and by bearing on the cope.

As may be noted from the gated castings, Fig. 2, each pair of castings has one pouring gate and a feeding gate is provided for each casting. These gates are formed on the pattern, by brass gate pins screwed to the plate. The heads of the screws are sunk into the brass and covered with solder which is caulked well in the hole. Brass is used for the gates and for any pieces which must be bent because the aluminum alloy is too stiff to stand much bending. Also fillets can be soldered more easily to brass than to No. 12 alloy. Another point of interest to this casting is the nub shown at *A*, Fig. 1. This is added to act as a feed to the thin section of the casting to which it is attached and also to prevent this edge from chilling. It also takes any dirty metal which might otherwise settle near the edge of the casting.

While this description serves to illustrate the general procedure in making plate patterns with an irregular parting and patterns with a flat plate are made on the same general principle, a number of striking points are illustrated in the method of handling different designs. The

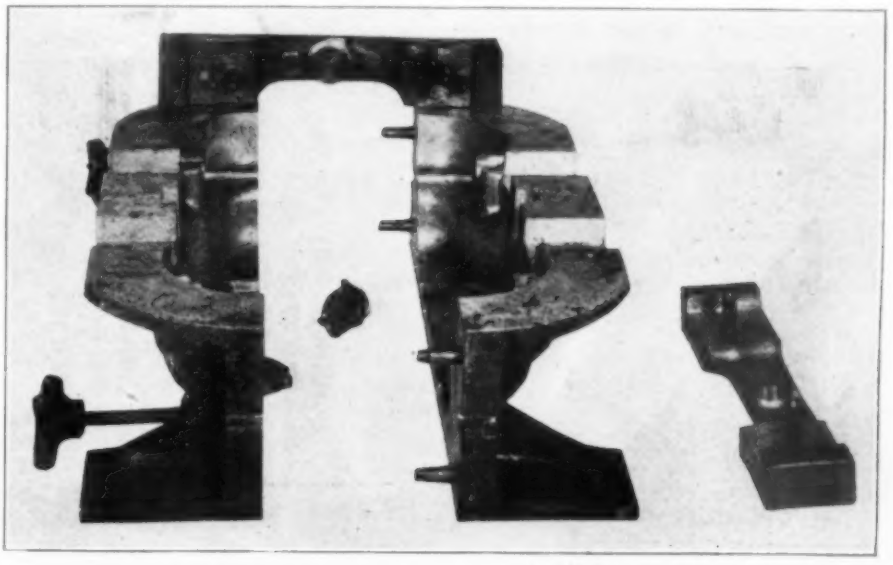


FIG. 11—CORE BOX FOR THE COVER PATTERN SHOWN IN FIG. 10

corebox for a distributor housing, Fig. 9, illustrates some interesting points in corebox construction. The method of clamping the two halves together is clearly shown. This is done by screwing down heavy cast-iron wing nuts, shown at *B* in both the closed and the open corebox. These wing nuts work on threaded rods attached to one half of the corebox by a hinge made by a pin fitted in two ears of a lug screwed to the corebox. The pin fits into the rod through a hole made by bending the end of the rod and is held in place by two cotter pins. The construction of the hinge may be noted at *C*, Fig. 9.

Loose Pieces on Slides

As may be noted this box contains several loose pieces shown at *D*, *E* and *F*, Fig. 9. Each piece is integral with a bar which slides under a plate screwed to the box at the parting line. Each bar has a dowel pin attached to it and the plate is machined out to let the dowel move back and forth. When the core is made, the top half of the box is lifted off and the loose pieces are withdrawn. In this position the dowels will fit into the holes in the drier which is laid on the box, but were the loose pieces not withdrawn, the dowels would not fit into the drier holes and it would be impossible to put it on the box. After the drier is placed over the core, the whole is rolled over and the corebox is then withdrawn leaving the core in the drier. Now before the two halves of the box can be put together to make the next core, the loose pieces must be pushed back into position or the dowels will not fit the holes in the other half of the corebox; thus, a core cannot be made with the loose pieces in a wrong position. The dark rings around the main dowel pinholes indicate the steel bushings set in to prevent rapid wear. Fig. 9 also shows the method of bolting plates to the corebox at points where it would be difficult to make the section a part of the corebox casting. At the top also may be noted the method of attaching a steel plate with screws around the opening through which the sand is rammed into the corebox.

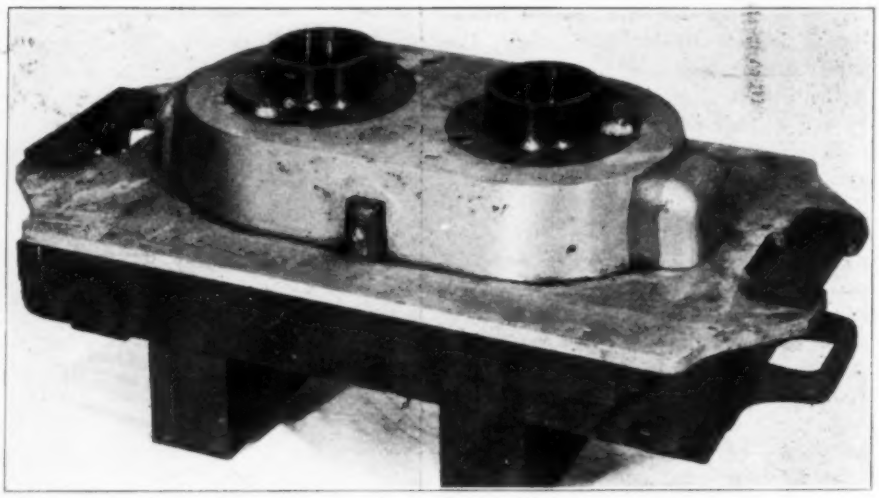


FIG. 13—PATTERN PLATE FOR AN END HOUSING CORE BOX OF WHICH IS SHOWN IN FIG. 12—NOTE THE WOODEN CARRIER ON WHICH IT IS HELD

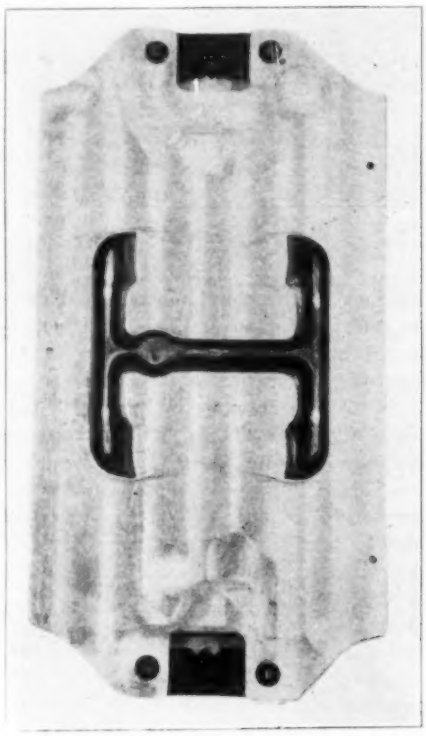


FIG. 14—DRAG SIDE OF THE PLATE FOR END HOUSING

A modification of the principle used in making the pattern for the distributor housing already described is used to make the plate for a casting which has a deep draw and no sides. This is illustrated by the side frame for the generator used on a Buick automobile. The drag and cope of a plate pattern for this gray-iron casting are shown in Fig. 8. The drag side of the pattern is cast as part of the plate and the cope side is cast separately and screwed to the plate. Fig. 8 also shows the front and back of the piece which is screwed to the plate to form the drag side of the mold. The loose piece, *H*, is attached to the pattern casting with screws while it is being machined. When sent to the foundry the loose piece is connected to the pattern by a dowel pin only. The dowel pinhole may be noted in the pattern plate above at the left, which shows the pattern with the loose piece out.

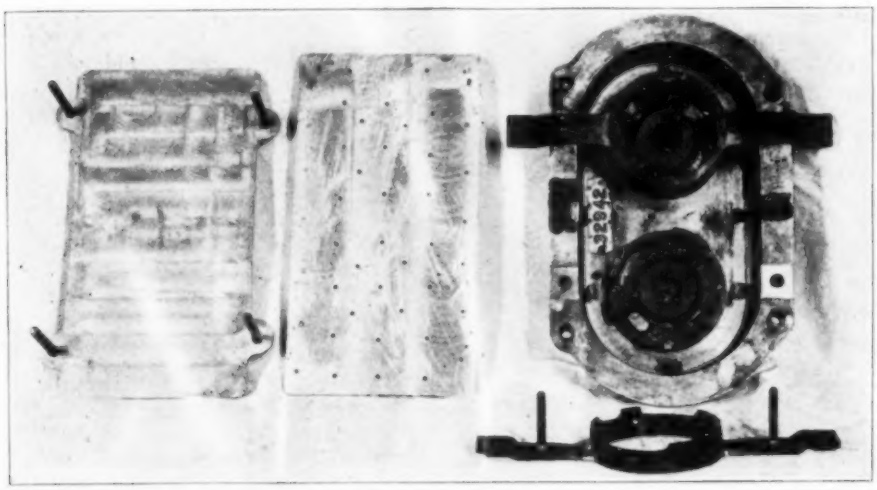


FIG. 12—CORE BOX, STRIPPING PLATE AND DRIER FOR MAKING END HOUSINGS, TWO IN A MOLD FORMED BY THE CORE

Has a Deep Draw

The pattern plate for a cover, Fig. 10, is shown to illustrate a pattern with a deep draw and a large core. As may be noted, the drag side of the plate is comparatively flat and the pattern casting is attached to the cope side only. The corebox is interesting as the core must form two bars each with a lug across the opening in the casting. This box is shown open in Fig. 11. The one bar is shown on the box and the other bars are beside it. To prevent the bars from being interchanged, the dowels are arranged farther apart on the one bar than on the other, and to prevent either of the bars from being placed on the box in the wrong position, one dowel is made larger than the other. Thus, the bar will fit in only one groove in just the right way. Two

small loose pieces may be noted, the one near the center of the illustration and the other protruding out of the left hand section of the box. These are fitted to the box with small studs and are released when the two parts of the box are separated. At the left may be noted the same kind of clamping device as has been described when mentioning the corebox for the distributor housing.

A somewhat novel pattern layout is shown in Figs. 12, 13 and 14 which illustrate the equipment for making end housings of aluminum, two in a mold. The casting is really made in a core contained in a cope and drag. The corebox, stripping plate and drier plate are shown in Fig. 12. The box proper is made of aluminum and is fitted with two brass patterns ported horizontally through the center. One of the upper sections of a pattern is shown removed and lying at the foot of the box. These two loose sections are equipped with different sized dowels, unequally spaced to prevent them being placed in a wrong position, similarly to the ones cited when describing the corebox for the cover casting.

In making the core, sand is first rammed to about the height of the lower section of the pattern. Then the two loose pieces are put on and sand is tucked under them and filled to the top of the box when it is struck off. The loose sections of the pattern are then withdrawn and sand is slicked over the grooves made by the side bars holding the pattern. The drier plate, shown directly at the left of the box is laid on and the stripping plate is put on top of it; then the whole is rolled over for drawing. The long pins on the stripping plate fit snugly against the sides of the drier plate and hold it in position besides serving as guides while raising the corebox. After beng dried, the core is placed in the drag mold made from the plate shown in Fig. 13. The wooden frame with the wooden cleats on the bottom and a cast iron handle at each end serves as a support for the pattern plate. The drag which is almost flat and contains the runners is made from the side of the plate shown in Fig. 14. This finished plate shows the iron castings bolted to the ears of the plate to act as guides for the flask pins. Instead of having one notch, each guide has two notches which are intended to give it a more rigid connection with the pin than were there only one notch.

Urges Simplicity in Storing Patterns

BY F. C. EDWARDS

A SHORT-SIGHTED policy in storing patterns sooner or later, will prove both expensive and exasperating. By this it is not implied that a costly or complicated system is necessary. On the contrary, as the writer's experience of many years goes to show, an inexpensive and simple method is not incompatible with highest efficiency.

Foundries differ so in their pattern requirements that one cannot hope to lay down a detailed plan applicable to all, but the principles here enunciated may be adapted to suit almost every case.

Assume, in the first place, that the pattern storage is in close proximity to the foundry, and that it is divided into bays and bins or shelves numbered consecutively. The manner in which it is arranged, of course, and the size of the bins, will depend upon the various classes of work handled. Large patterns, and those that are used frequently should be given preferential consideration, with regard to position, so as to facilitate handling. The smaller patterns should be placed on shelves that are well lighted and every advantage taken of all sources of daylight for the latter is cheaper, healthier, and not so risky as artificial light. Tiers of shelves therefore should be arranged on each side of the windows, and not placed in front thus shutting off the light.

Every pattern, however small and unimportant, should bear a distinctive number as a mark of identification both of pattern and casting. Various methods of numbering patterns are used. Some are so unwieldy that they cannot be applied to a pattern unless it has a space somewhere on the top or bottom as molded equal to a sheet of notepaper; and the mark is reminiscent of war-time *government permits*. A pattern that carries the catalog number of the machine to which it belongs, together with the number of the drawer in the particular drawing office from which it emanated and the part number on the drawing may be of interest as an example of perfect systematizing, but in actual practice, the only real test, it is found wanting. In this matter, as in many other every-day problems, simplicity, and economy of symbols give the best results.

Bear in mind that the main object of numbering a pattern is to enable the man in charge of the stoves to locate it quickly, and any figures relating to drawings, etc., so far as he is concerned, are superfluous and may give rise to serious mistakes.

The writer has found that consecutive numbers, prefaced by a letter denoting the class of work or the department to which the job belongs, answers all requirements. The numbers originate from the drawing office of the departments, or, in the case of a central drawing office, from that section dealing with the class of work for which the pattern has to be made. These numbers, taken from the pattern-record book which contains all necessary particulars relating to each pattern, are entered on the drawing.

The numbers, say for the crane manufacturing department, would be prefaced by the letter *C*. When the pattern is made it is stamped with the number shown on the blueprint, say *C*43, and, if practicable, raised figures are added. At the same time, the description of the pattern is entered against *C*43 in the pattern-shop register, with cost of pattern, etc. A duplicate register is kept of each letter, *C*, *F*, etc., in the pattern stores and is posted periodically. On the arrival of the pattern at the storage room the number of the locker in which the pattern will be kept is entered opposite the number 43 in the *C* book. The shelf or bin number subsequently is entered in the pattern-shop register. From this it will be seen that in the event of one of the registers being destroyed by fire, or other causes, the essential particulars relating to each pattern may be obtained from the others.

Apex Electric Company Has New Foundry

The Apex Electrical Mfg. Co., Cleveland, recently purchased two acres of land with three factory buildings on it at East Seventy-ninth street and Bessemer avenue, on the Erie railroad, and is remodeling the buildings to be used as brass and aluminum foundries and as a small motor factory. This is the third extension of the company. It builds electric washers and ironers and electric vacuum cleaners.

The Schied Engineering Corp., 90 West street, New York, has been appointed metropolitan and export representative for the Franklin Moore Co., Winsted, Conn., manufacturers of material handling machinery for industrial plants.

Melts Iron for Piston Rings

Oil-Fired Furnace Equipped with Pyrometers Produces a Satisfactory Metal—Oxidation Causes Hard Iron in the Rings as Also Does Low Carbon Contents in the Original Charge

BY B. H. ARNOLD

ON THE production of high grade piston rings, the foundry art is of prime importance, for without the proper material, the best of design and workmanship are baffled. Cast iron for well known reasons has become the accepted material, but as generally produced leaves something to be desired in elasticity and ability to hold its shape. The cupola, even under the best condition is unable to furnish a cast iron of sufficiently low sulphur content to prevent distortion of the rings under the repeated heatings of internal combustion engine service.

With the intent to make the best possible, individually cast piston rings, the Seymour Laboratories Units, Inc., Milwaukee, after considerable study of ring manufacture and of the melting and refining apparatus in use, selected an oil-fired regenerative furnace. This furnace was designed and built primarily for melting and refining the high grade gray iron desired by the automotive industry. The construction is shown in Fig. 3. The cylindrical shell is of riveted steel plate and the ends of cast steel. The length is about 9½ feet and the diameter 6½ feet. When first installed the bottom was of chrome brick and the remainder of the lining of high grade silica brick. Later the bottom was changed to silica sand with a saving in maintenance cost. Every Sunday, when the furnace has been operated throughout the week, the lining is repaired with fireclay and the bottom replaced with fresh sand.

The fuel oil is fed to the two burners, *AA* by a rotary pump. The oil is heated by a coil of resistance wire, wound around the oil pipe through which a current of electricity is passed; also by the supply pipe being in close contact with the furnace shell for some distance. The air pressure is maintained by a constant pressure blower, which furnishes only enough air to give a substantial velocity to the combustible mixture the remainder being drawn, by injector action from outside the building, through suitably arranged pipes within, and heated by the waste heat passing up the stacks.

Jets Impinge on Each Other

The burners are so located that the flame jets impinge on each other similar to the old style gas illuminating tips, thus distributing the heat throughout the furnace. Each burner has its own valve and in addition there is another at *B*, Fig. 3, shutting off both burners at once and governing the mixture as a whole. The air has only the one control at *C* in the supply pipe from the blower, acting thereby on both burners and also on a third blast *D*, at the top center of the furnace. Air only is admitted at this point, and from some slight experiments, it is believed that it will be to advantage to have an independent control on this blast to reduce the amount of air as the melting progresses.

The preliminary study of piston rings made it comparatively easy to obtain material of the desired analysis during the early or experimental period of furnace operation. Few difficulties were met, considering the lack of experience with this melting method. The only one worthy of discussion was dirt in the iron, principally slag from previous heats as the temperature prevents economical cleaning between frequent heats. This dirt was in such quantities and so located as to seriously reduce the usable output. The amount of stock allowed on individually cast rings being extremely small, on the sides generally under 0.02-inch, a very small amount of foreign matter will pre-the casting cleaning up.

A number of fluxes were tried, including glass, but with indifferent success, excepting possibly when using fluor spar. This was thrown in during the last of the melting. The resultant thin fluid slag rising to the top of the bath was allowed to run off after the pouring. The trouble from slag was finally overcome, satisfactorily and economically by shutting off the fire, opening the side doors and rabbling and slagging as in malleable practice, twice during

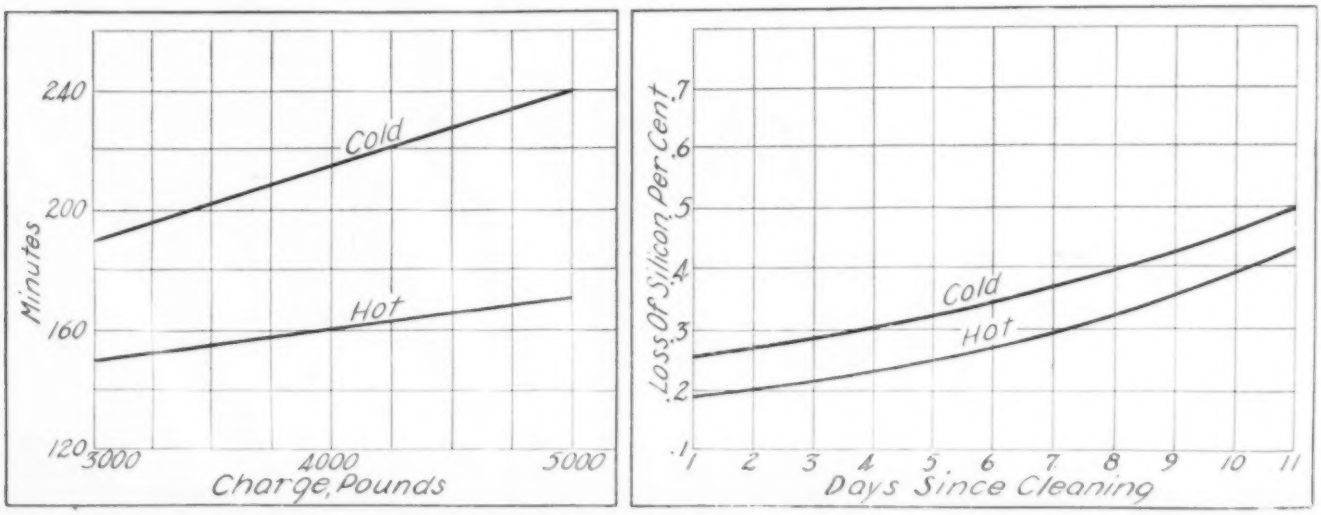


FIG. 1—CHART SHOWING RELATION BETWEEN WEIGHT OF CHARGE AND MELTING TIME WITH BOTH A COLD AND A HOT FURNACE. FIG. 2—THE SILICON LOSS IS LESS WHEN THE FURNACE IS CLEANED AND A NEW BOTTOM MADE

the latter part of the melting, no flux of any kind being used. This practice not only cleans the iron, but it insures a more uniform temperature throughout the bath, the source of heat being above hindering circulation. At first it was feared that the time the fire was off might adversely affect the bath, but the five or six minutes net reduction caused no ill effects. The second slagging time affording opportunity to make the wedge test. This slagging did not make the iron absolutely clean as the rings must be poured with iron as cold as can be made to fill the molds, but the reduction was such that with a few additional small expedients in molding and pouring, the results were eminently satisfactory.

Temperature a Controlling Factor

An important lesson of the proper pig iron for the successful operation was learned rather expensively during production, instead of in the development period where it belonged. The first shipment of iron used for the experimental work and the first of the production happened to be right. This was a pig iron smelted at a low temperature and uniformly of the following analysis:

	Per cent
Silicon	4.00
Sulphur	0.03
Phosphorus	0.60
Manganese	0.60
Total carbon	4.00

Silicon Per cent	Variation of Other Elements in Eight Cylinders	Per cent
1.42	Combined carbon	0.26 to 0.59
1.54	Graphitic carbon	2.74 to 3.22
1.56	Total carbon	3.29 to 3.54
1.59	Phosphorus	0.26 to 0.61
1.79	Sulphur	0.083 to 0.113
1.85	Manganese	0.50 to 0.66
		Pounds
2.11	Transverse strength	2,480 to 3,140
		Pounds per sq. in.
2.12	Tensile strength	19,900 to 30,200

Silicon Per cent	Variation of Other Elements in Eight Liners	Per cent
1.03	Combined carbon	0.56 to 0.80

FOUNDRY LOG SHEET — Heat No. 157

Floor Rings — Date 7-1-21

Weather Fair & Warm — Since Cleaned 5th day — Fire Off 19hr 20'

Time	Temperature Flame	Temperature Body	Air Pres.	Oil		Remarks
12:45	275	925	4.0			Preheat Started
1:18	1000					Charge Started
1:30	700		3.9			Fire On
				water 0.1 of meter		
4:24	1650	950	3.7			1st Slag.
4:33	1200					Fire On
5:00	1550	950				2d Slag
5:05	1150					Fire On.
5:15	1700	960	3.6			Tap
5:28	1600					Floor Poured
5:33	1530	960				Fire Off

Charge — Signed J. G. Albright.

Material Kind	Car No	Weight Lbs.	Silicon %	Silicon Lbs.	Mang %	Mang Lbs.	Phos. %	Phos. Lbs.	Sulphur %	Sulphur Lbs.	Carbon %	Carbon Lbs.
Pig	395133	3600	3.43	124.20	.60		60					
"	28791	400	4.15	16.60	60		60					
	Total.	4000	3.52	140.8	60		60					
Analysis		A C	3.13	3.20	44	47					C.C. 28-T.C. 3.23	

Physical Record

			Wedge Bar	
Machining OK	Elasticity Good		Chill	Fluidity
Sclerescope	Brinnell			
Molding Practise Gates very clean - rings good.		Fst	1/8"	Good
		Mid		
Last of heat few hard spots		Lst	3/8"	Fair

FIG. 4—THE FOUNDRY LOG SHEET GIVES A HISTORY OF EACH INDIVIDUAL HEAT

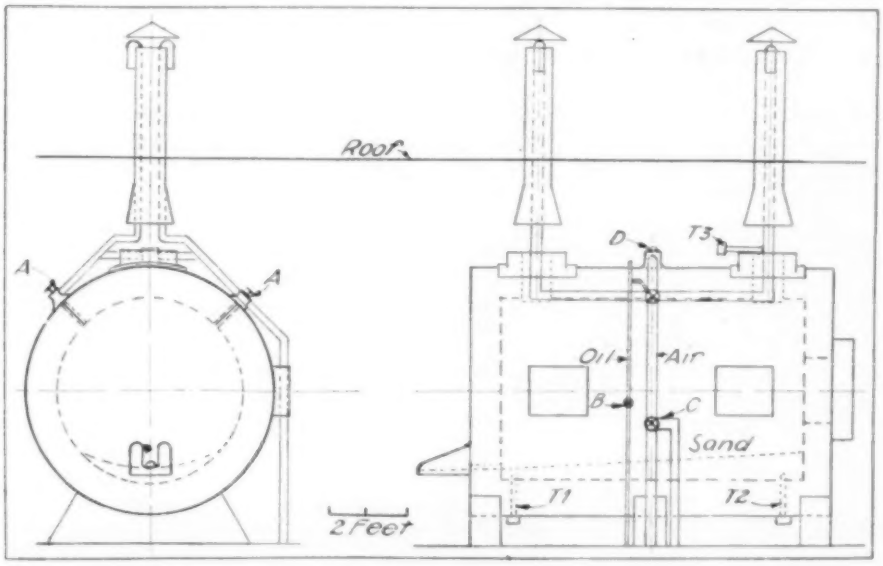


FIG. 3—END AND SIDE ELEVATIONS OF THE FURNACE

1.55	Graphitic carbon	2.61 to 2.95
1.59	Total carbon	3.30 to 3.58
1.04	Phosphorus	0.30 to 0.61
1.71	Sulphur	0.077 to 0.100
1.75	Manganese	0.53 to 0.90
		Pounds
1.76	Transverse strength	2,280 to 3,024
		Pounds per sq. in.
2.16	Tensile strength	22,800 to 33,400

Silicon Per cent	Variation of Other Elements in Three Pistons	Per cent
1.35	Combined carbon	0.60 to 0.72
1.57	Graphitic carbon	2.69 to 2.78
2.12	Total carbon	3.38 to 3.41
....	Phosphorus	0.30 to 0.61
....	Sulphur	0.078 to 0.097
....	Manganese	0.64 to 0.81
		Pounds
....	Transverse strength	2,480 to 3,140
		Pounds per sq. in.
....	Tensile strength	27,100 to 32,300

A pig iron of approximately the same analysis but smelted at a high temperature was tried. This caused hard rings even when used in so small a quantity as 10 per cent of the total charge. The pigs must be of uniform analysis as the furnace capacity is small,

and the iron selected for charging may not represent the average of widely varying carload. Good heats can be obtained from pig iron with silicon varying 0.025 per cent from the composition given, provided it is uniformly so, but pig iron containing less than 3.75 per cent silicon requires the addition of iron higher in silicon, generally low in carbon, which will cause hard castings by lack of total carbon charged. This point must be watched carefully and every effort made to keep the total carbon charged above 3.60. As low sulphur castings are the objective, the sulphur in the pig is specified as low as possible without interfering with economical purchasing, 0.02 to 0.04 per cent being satisfactory.

With all difficulties seemingly overcome by the experimental operation,

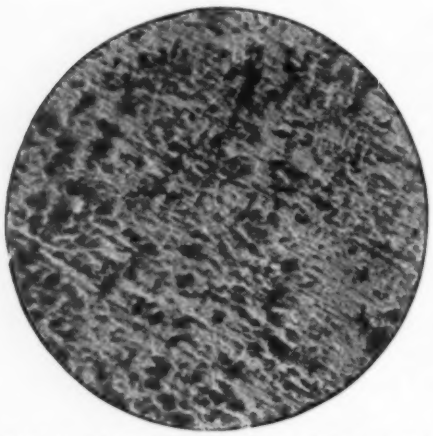


FIG. 5—MICROGRAPH OF A RING MADE FROM METAL MELTED IN THE OIL FURNACE

regular production brought out other obstacles of the sort that keep the foundryman from a monotonous existence. Where the heats had been not oftener than every other day and not exceeding 2500 pounds, the furnace maximum of 5500 pounds was attempted daily. Thereupon hard castings became of noticeable frequence and regularity at the end of the week. The silicon and manganese losses varied so widely that it was by accident that the right analysis was approximated. This latter trouble was shown to be due to the use of a car of resale iron, the car analysis covering a wide range of silicon and manganese.

Pyrometer Is Installed

Further investigation showing there were several factors that might be concerned, a pyrometer was installed and a log sheet devised to record for detailed study the variables of the different heats. One of these sheets filled out with the data gathered from a heat is shown in Fig. 4. The table in the upper portion of the log sheet records in degrees Fahr. the temperature of the flame and of the lining, or body, as recorded by the pyrometers at *T*3 and *T*1, Fig. 3, together with remarks as noted during the heat. The lower chart gives the analysis of the charge and the finished metal, as well as a record of the physical characteristics of the metal.

Proper Location

The pyrometer used was a recording instrument with a platinum-rhodium couple in each end of the furnace bottom, *T*1 and *T*2, Fig. 3. The couple at the low or tapping end furnished the temperature at which the lining should be before charging, approximately 500 degrees Fahr. thereby reducing the melting time and hard castings. This information was obtained by an after-study of several heats, as there is a 6 to 8 hour lapse between the temperature change and its recording which prevents the use of this location in production operation. However, experience showed that if the furnace was preheated for 20 minutes for each 10 hours without fire, the lining will be sufficiently hot.

Much loss of iron can be prevented by having a thermocouple so located as to give the lining temperature quickly and at the same time that of the iron at the bottom of the bath and close to the breast, as frequently it was necessary to throw out the first few ladles, the top of the bath looking right for tapping but the bottom too cold to fill the molds. Opportunity has not as yet been found to determine this location, but it is hoped to soon locate a pyrometer at the proper place to give this information.

The couple at the high or charging end was too short and too far from the bath to record anything worth mentioning, so it was placed in the stacks at the charging end, as indicated at *T*3, Fig. 3. There it furnished interesting and valuable data. The chart made from this couple was an accurate chronological record of the handling of the furnace. The sensitiveness was such that with the furnace cooling for 18 hours, opening or closing the charging door would show at once on the chart. It had been believed that the handling of the furnace was quite uniform but the chart showed many possibilities whereby the various steps could be and were made more systematic and productive.

The temperatures obtained from the stack were disappointing as an indication of the condition of the bath, maximums of from 1400 to 2150 degrees Fahr. being recorded just previous to the tapping This range can be caused by, incrusta- of successful heats of the same size. tions on the nichrome protecting tube of the couple, slag on the bath reflecting the heat, and particularly variations in the proportions of oil and air. A slow burning mixture giving low heat over the bath and high stack temperature, while a quick burning one will give the reverse conditions. During the early stages of the melting, one stack might show a predominace of flame due to piling of the charge, but this usually equalized as the iron melted. Dirty or carbonized burner tubes were found to deflect the flame to a certain extent. If necessary a tube can be removed and replaced during a heat, so quickly that the time the fire is off will have no ill effects.

In view of the forgoing it is believed that an optical pyrometer used through the slagging doors on the surface of the

FIG. 6—MICROGRAPH OF A RING MADE FROM METAL MELTED IN A CUPOLA

bath and again on the stream as it flows down the spout, will do much to prevent heats lost because of too cold or too hot iron; judging the temperature by color is a comparative method and on dark days there will be occasionally a large number of lost molds.

Upon first consideration it would seem more economical, per pound of iron, to melt large heats rather than small ones but experience showed differently. With large charges, there seemed to be an oxidation that increases with the time since the furnace was cleaned, or is cumulative, daily heats of 5000 pounds, always giving hard castings on Saturday and frequently on Friday. On the other hand two heats of 3500 pounds per day gave no trouble.

Two or More Furnaces Needed

With an installation of two or more furnaces there should be less trouble and a greater economy of operation. A furnace could be used to its maximum for three or four days and then shut down for cleaning, while one of the others carries the load. Unfortunately

the conditions did not warrant the added investment.

In the casting of individual piston rings there is considerable wastage in gates and sprues, which the economical foundryman naturally wishes to remelt, but with over 15 per cent of scrap in the charge there is extreme liability to hard rings. With castings of larger section than the rings, such as ring pots, the scrap could be run to 45 per cent without difficulty.

The hardness that so frequently appeared is a chilling, but the cause was not satisfactorily determined. In some cases it is a matter of carbon. However, the consensus of opinion is that the hardness is due to oxidation, the top of bath being overexposed to the flame during the extended melting.

When a considerable number of the log sheets were completed the data was tabulated and plotted, the resulting curves giving the needed information as to proper melting time. Fig. 1, and of the losses, Fig. 2. The substance of these curves was, of course, apparent before, but the definite values decidedly unappreciated. The difference in melting time with a hot and a cold furnace demonstrates the desirably of preheating. The cold furnace chart was plotted from heats made after the furnace was without fire for at least 15 hours, and the hot-furnace chart was plotted from heats charged immediately following the tapping of a previous heat.

Silicon Loss High in Large Charges

The loss curve shown is for silicon only, the manganese being approximately one third of the silicon loss. As would be expected the shorter melting time with the hot furnace reduces the losses, even though the second heat is further from the cleaning. The rising of the curve toward the end of the week, is believed to be a further indication of the cumulative effect of lack of cleaning noticed with the large heats as hard castings. These loss curves are for 3500-pound charges, with 500 pounds of scrap included. Larger charges and more scrap increase the losses, though not proportionally.

Many foundrymen accustomed to the cupola will doubtless think this furnace at least undesirable, but the product is so satisfactory for piston rings that extra precautions, decreasing as familiarity is gained, are fully warranted. The modulus of elasticity is between 17,000,000 and 19,000,000 pounds and the tensile strength between 25,000 and 30,000 pounds per square inch, averaging close to the higher value. The texture is uniformly fine and the components well distributed as may be noted in Fig. 5, a micrograph of a ring section. This should be compared with Fig. 6, a micrograph of a ring made by one of the well known manufacturers from cupola iron.

The information given, though admittedly incomplete and conclusive from a scientific viewpoint, is the result of experience gained during a fairly intensive drive for production in a small concern and much desirable equipment was unavailable. But the equipment the iron obtained is such that it is hoped that the foregoing will become through discussion and criticism, the basis for further work in producing the much sought ideal piston ring material.

Manufacture Soil Pipe

Cast iron soil pipe and fittings and other castings are being manufactured by the McChesney Foundry & Mfg. Co. which recently was incorporated at $35,000 to operate a foundry at 3004 Madera street and stock rooms at 812 Texas street, El Paso, Tex. This is said to be the only plant of this kind within 1000 miles of El Paso. In addition to patented floor drains and other pipe fittings, it manufactures warm air furnaces, hot water heating plants, grates, sash weights, coal chutes, and other castings. L. P. McChesney is president of the company and with W. S. Dobie and Judge S. J. Isaacs was one of the incorporators. J. O. Crawford is sales manager.

Trolleys Are Adapted to Various Uses

The I-beam systems with which many foundries are equipped frequently are used for many purposes other than the one for which they have been installed. The same system which serves to carry the hot metal around the foundry also may be utilized to convey the castings to the cleaning department. One adaptation of the I-beam system in the Superior Foundry Co., Cleveland, is shown in the accompanying illustration. In this case two chain blocks are attached to trolleys on the I-beam. A chain block is attached to each end of a wood platform by a bar-steel yoke. This platform then serves to carry water heaters to the shipping room. When the platform carrier is not needed it can be detached from the chain blocks which are then independent of each other and are available for other purposes. As may be noted, the chain blocks are attached to the trolleys by a hook which fits into an eye in the trolley. Therefore, it is easy to detach them and equip the trolleys with hooks for carrying tote boxes or ladles as required.

A PLATFORM IS READILY ATTACHED TO TWO TROLLEYS TO FORM A CONVEYOR —OTHERWISE THE TROLLEYS MAY BE USED INDEPENDENTLY

Analyzes Sand Screen Tests

Mathematical Investigations Indicate Effect of Grains of Different Shapes and Sizes on Perviousness of Molding Sand—Method of Testing Is Outlined and a Number of Conclusions Are Drawn

BY H. A. SCHWARTZ

AMONG the tests frequently applied to define the quality of a given sand is the so-called screen test which indicates the relative amounts of the sand passing through one and retained in the next of a series of screens having mesh sizes of more or less arbitrary gradation. The test is cheaply made and does constitute a fairly useful method of comparing two sands supposed to be identical. Presumably it furnishes information as to the porosity of the sand and as to

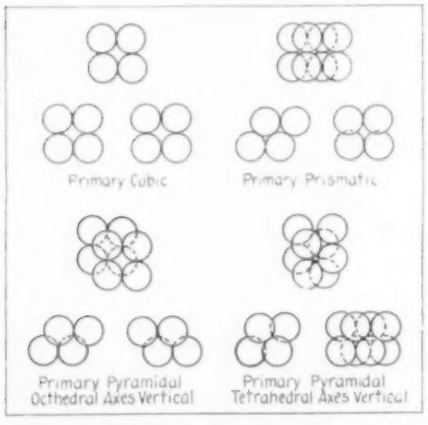


FIG. 1—PRIMARY SYSTEM OF GRAIN ARRANGEMENT

the smoothness of surface of a mold made therefrom. Moreover, there is a general opinion that perfection of mold surface can be had only at the expense of poor venting properties and *vice versa*.

Two facts may easily be overlooked in the interpretation of any such test for practical purposes. First, the porosity of a mixture of grains of various sizes is not the weighted mean of the porosities of the several constituent grain sizes. Second, the porosity of a dry sand is far different from that of the same sand moistened to the degree encountered in foundry practice.

A further complicating factor is that as yet there is no orderly and logical selection as to the fineness of sieves used for the purpose of testing sands and hence there is a possibility of going far astray in an attmpt to correlate data based on different selections of sieves.

This paper has been prepared with a view to rendering available certain data gathered by the writer in 1910 in a preliminary survey of these aspects of the subject. It must be understood that no presumption to completeness and finality is set up. It is hoped that certain sources of error in the applications of screen tests, not entirely obvious to the foundryman, may be pointed out.

Molding sands consist of rounded quartz pebbles of small size more or less coated with clay. Some idea of the complexity of any mathematical interpretation of porosity in terms of grain size may be gained from a mathematical investigation as to some of the simpler groupings of spheres in space. The simplest symmetrical grouping is that where eight spheres of equal size are so arranged that their centers are situated at the corners of a cube. In that case if d represents the diameter of the sphere, the sphere centers are separated by distance d and the spheres themselves represent $\frac{\pi}{6}$ times the total volume of the mass.

The next simplest arrangement is one in which the centers of the spheres occupy the six corners of a right equilateral prism. In that case the sphere centers are also a distance d apart, but the spheres now occupy $\frac{\pi}{3\sqrt{3}} = \frac{\pi}{5.19}$ times the total volume. In other words, the spheres are more compact than in the case of the cubic arrangement.

The remaining symmetrical arrangement is one where the centers of adjacent spheres are at the points of a regular octahedron whose edges have a length d in which case the spheres occupy $\frac{\pi}{3\sqrt{2}} = \frac{\pi}{4.23}$ of the total volume a still closer pack than either of the preceding. This spacing automatically includes two tetrahedra for each octahedron.

Still another arrangement is the tetrahedral in which the centers of the spheres are at the vertices of regular tetrahedra. The volume of the sphere then is $\frac{\pi}{3\sqrt{2}} = \frac{\pi}{4.23}$ of the total volume identical with the octahedral pack. Also each pair of tetrahedra is accompanied by an octahedron. That

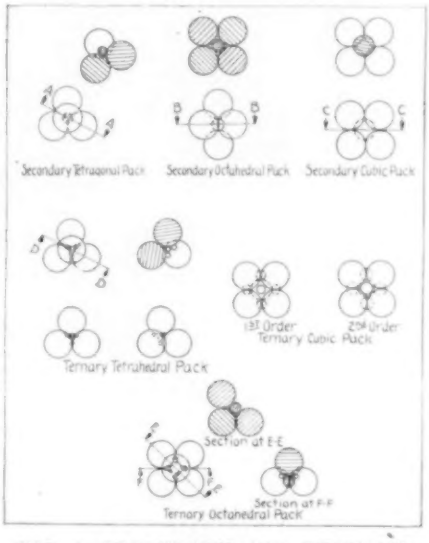


FIG. 2—SECONDARY AND TERNARY SYSTEMS

is, the pack is identical with the preceding except in orientation as a whole.

Other less dense and unsymmetrical packings can be imagined. It is obvious that a mass of spheres free to move or rammed into place in a container having dimensions a multiple of their diameters will arrange themselves in the densest pack possible—the tetrahedral, octahedral—and that the density of packing of uniform sized spheres is then independent of the diameter.

This, however, does not mean that the porosity of all the systems, in the sense of resistance to air flow, will be the same irrespective of the diameter chosen.

The resistance of a passage to the flow of a gas or liquid fluid is in general directly proportional to its length and perimeter and inversely as

Paper presented at the Rochester meeting of the American Foundrymen's association. The author is manager of research, the National Malleable Castings Co., Cleveland.

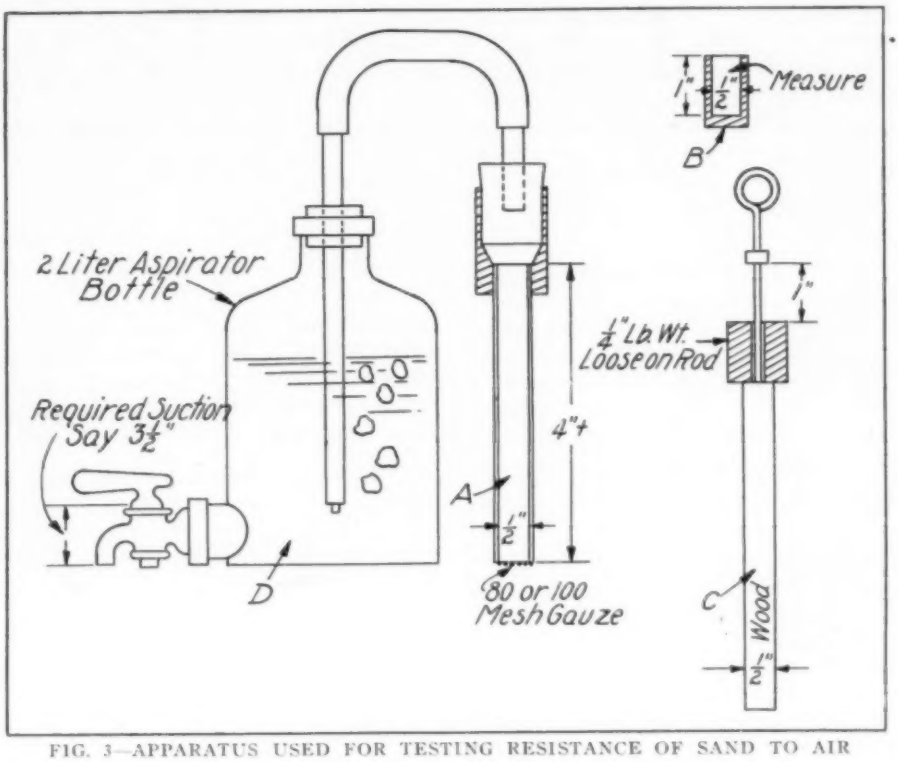


FIG. 3—APPARATUS USED FOR TESTING RESISTANCE OF SAND TO AIR

its area. Per unit length therefore it is proportional to the perimeter divided by the area of the passage. The reciprocal of this figure is a geometric constant known as the hydraulic radius.

In any given pack of uniform spheres the area of cross section varies as the square of the diameter chosen while the mean perimeter varies as the diameter; the frictional resistance per unit length to fluid flow thus is inversely as the diameter of the spheres and the sand's perviousness to gas is inversely in this proportion. This is based on the supposition that the gas does not frequently have its direction reversed by having to flow around obstacles.

If this condition does exist, the number of changes of direction per unit length should be a straight line function of the size of sphere; hence the resistance to flow would again be an inverse function of the grain size in a given pack. It would be simple, but of doubtful utility, to calculate the hydraulic radius for the form of passage in the three packs and so show their relative resistance to flow.

We may turn now to the more complex systems of spheres varying in size. For our present purpose they may be considered primarily as modifications of the previous systems by additions of other spheres.

For instance, if a circle be drawn externally tangent to three equal circles tangent to each other, and if d be the diameter of the equal circles d, the diameter of the fourth circle will be $\left(\frac{2}{3}\sqrt{3}-1\right)d$ or $d_1=.154d$. Similarly for a circle tangent to four equal circles tangent to each other the diameter d_2 will be $(\sqrt{2}-1)d$ or $d_2=.414d$.

Any sphere having a diameter larger than d_1 can not pass outside any octahedron or tetrahedron in which it finds itself and similarly any sphere larger in diameter than d_2 can not pass the sides of the cubic or triangular prism elements of that pack.

The sphere tangent to six spheres of diameter d arranged in the octahedral system will also have a diameter of d_2, the problems being identical.

This is the largest sphere which can be packed into the center of an octahedron without preventing the contact of the six spheres of the primary system. Any sphere whose diameter is greater than d, and less than d_2 will fit loosely within the octahedron and any spheres smaller than d, sift down through the primary structure of larger spheres.

The sphere tangent to the spheres of the tetrahedral system has a diameter $d_3=(\frac{1}{4}\sqrt{6}-\frac{1}{2})$ or $d_3=.220d$.

What has been said of spheres having diameters of d_1 and d_2 in the octahedral arrangement applies to diameters of d_3 and d_3 in the tetrahedral.

We can see that in the pyramidal pack consisting of one octahedron and two te-

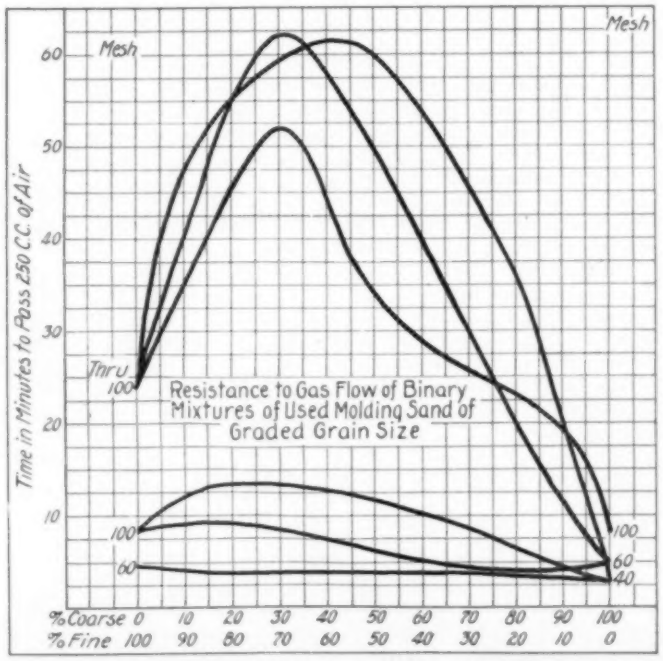


FIG. 4—RESISTANCE OF DRY SANDS TO GAS FLOW

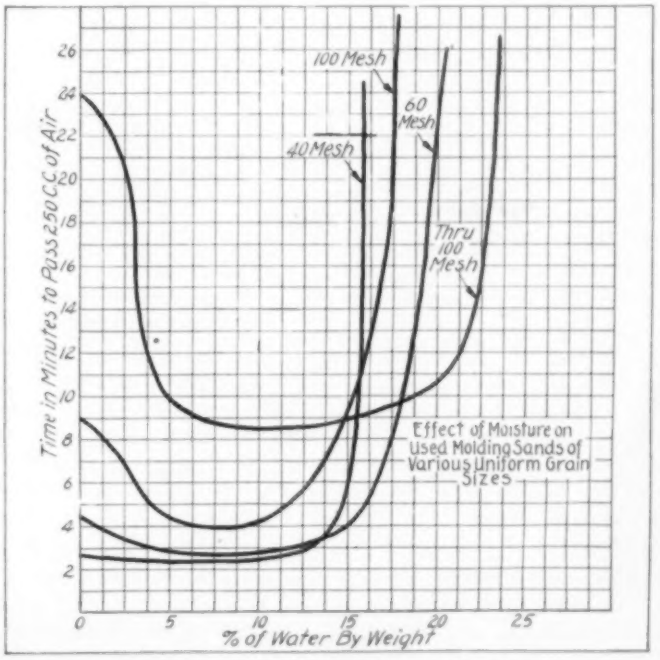


FIG. 5—EFFECT OF MOISTURE ON USED SAND

trahedrons in each unit (i.e. per each primary sphere of diameter d) we may add one sphere of diameter d_2 and two of diameter d_3. This combination is the densest possible, using only one extra sphere in each regular polyhedron. The density of the pack has been increased from $\frac{\pi}{4.23}$ of the total volume solid to $\frac{\pi}{3.87}$ or by 9.2 per cent of its original value.

The resistance to flow would be increased much more rapidly, for the interposition of the extra spheres would enormously decrease the mean area of the passages and increase their perimeter. If too many of the smaller sizes of spheres be added or they be too large the whole structure is loosened up by their wedging action on the primary structure. We might readily proceed to calculate still other smaller spheres to fit the various interstices of the system of primary and secondary spheres already calculated. We should then get an endless series of different numbers of various sizes of spheres which would give the maximum density. Such a series being calculated, any change in relative numbers and dimensions would produce a loosening up of the structure either by leaving voids if the small ones were too small or too few or by wedging if they be too large.

The mix just calculated for the primary and secondary series of the pyramidal system corresponds by volume and hence by weight to the following:

Number of spheres	Diameter	Volume or Weight	Per cent of total
1	d	$1.000\frac{\pi d^3}{6}$	91.58
1	$.414d$	$.071\frac{\pi d^3}{6}$	6.50
2	$.22\ d$	$.021\frac{\pi d^3}{6}$	1.92
—		—	—
4		$1.092\frac{\pi d^3}{6}$	100.00

With sufficient patience and mathematics we could similarly calculate the percentage composition of a series of any desired degree of complexity.

A further complication may arise where the spheres of the secondary series are of such dimensions as to rearrange the geometric system of the primary pack. The sphere tangent to four spheres in the cubic pack has a diameter of $.732d = d_4$ and therefore the cubic system will accommodate one sphere of this diameter for every sphere of diameter d.

The density of the pack is increased 39.2 per cent to $\frac{\pi}{4.31}$ a density but little less than that of the pyramidal primary system.

If to the latter system spheres larger in diameter than d_2 or d_3 be added the pack would be loosened, if, however, the number and size were as indicated above the pack would become primary and secondary cubical with a possible increase in density.

Thus it is indicated, for example, that a mix of equal numbers of spheres of diameters d and d_4 has the same density although not necessarily the same resistance to flow as one all composed of diameter d or d_4, which is not necessarily obvious at first glance.

We have so far dealt with a primary series and a secondary series composed

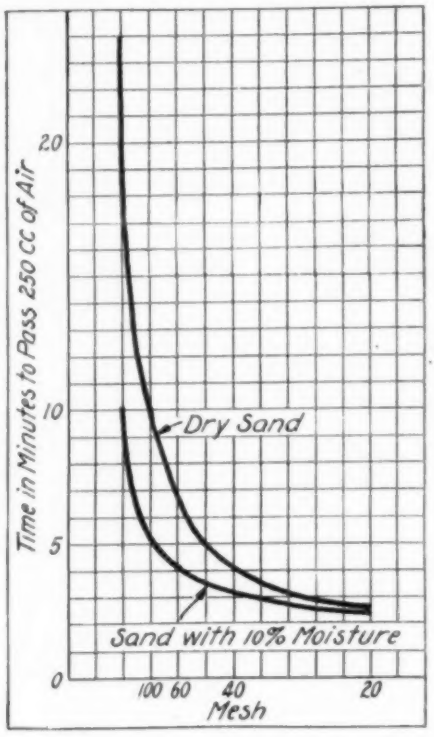


FIG. 6—EFFECT OF GRAIN SIZE ON IMPERVIOUSNESS OF MOLDING SAND OF UNIFORM GRAIN SIZE

of spheres of smaller diameter than the primary. The ternary series can be readily studied. For example in the pyramidal pack we could introduce at each triangular face a ball of diameter d, without touching the secondary spheres of diameter d_2 and d_3. This would give seven spheres of diameter d, for each sphere of diameter d and the pack would become:

Number of spheres	Diameter	Volume or Weight	Per cent of total
1	d	$1.000\frac{\pi d^3}{6}$	89.5
1	$.414d$	$.071\frac{\pi d^3}{6}$	6.3
2	$.22\ d$	$.021\frac{\pi d^3}{6}$	1.9
7	$.154d$	$.026\frac{\pi d^3}{6}$	2.3
—		—	—
		$1.118\frac{\pi d^3}{6}$	100.0

The pack is increased in density 11.8 per cent over that of the primary but of course much more in imperviousness as each secondary and ternary sphere greatly decreases the cross section and increases the surface of the passages through which gas can flow.

In the cubic pack a sphere of diameter d_2 can not be introduced as a ternary sphere the maximum diameter which will not touch the secondary series being $.268d$.

Another pack, however, is possible in which the ternary spheres have a diameter $.414d$ and the secondary sphere touches these and not the primary. The secondary sphere then has a diameter $.586d$.

The tremendous complexity of calculating resistance to flow from the dimensions of such complex structures is obvious.

If we added a large number of large spheres we would disarrange the primary series by substituting a new primary system corresponding to the larger spheres. Without attempting a formal mathematical solution it will be evident by inspection that if we buried a larger sphere in a mass of relatively quite small ones, it would with but an insignificant disturbance of a few small spheres near its surface render impervious a large volume of the mass it occupies.

A further instance is the second order cubic pack already described. We need speculate no farther. Enough has been said to indicate that the design of a suitably graded series of screens even for a single sand and the interpretation of its result into terms of porosity or venting properties is inherently too complex to be considered an experimental possibility. The matter is further complicated by the consideration that the natural sands are not perfectly spherical and consist of a uniform gradation of sizes and not of groups differing in size by sharp limits.

It can be seen that an absolutely even size of grain gives the most open sand. Such sands do not exist in nature and while it may be assumed that the nearer any natural sand is to even grain size the more open it will be, even this generalization may fail where the mixture of sizes is very complex.

Experimental Data

Fortunately we are not dependent on sieve tests to determine the resistance of sand to the passage of air or its perviousness. The problem is capable of simple and direct observation by deter-

mining the rate of flow of air through the sand at some selected pressure.

The data may be expressed either in volume of air per unit of time or in time per unit volume. The two are reciprocally related and the latter form is a more direct measure of the property of interest in the foundry than the former.

The form of test is by no means original with the author. As conducted by him it consisted of ramming into the tube *A*, shown in Fig. 3, three successive measured lots of sand from the measure *B*, each filling the tube 1 inch deep before ramming. Each layer was settled in place by three blows of a weight of ¼ pound falling 1 inch, by means of the rammer *C*. The time was observed for 250 cubic centimeters of water to flow out of the aspirator bottle *D* under a constant fixed arbitrary head of about 3½ inches.

Pains must be taken to avoid leaks and also to make sure that the water level within the tube in the aspirator bottle is at the bottom of the tube and bubbles flowing before beginning the experiment.

The apparatus was used primarily for the direct measurement of the resistance to flow of natural and used molding sands. For purposes of experiment a given sand was separated into fractions by screening through 20, 40, 60, 80 and 100 mesh sieves. The various fractions were then combined in various definite properties two at a time, and the resistance to flow of air of the binary mixtures determined.

The data on dry sands are plotted in Fig. 4. It should be noted that except by chance the resistance of the mixture is never the weighted average of the resistances of the separate ingredients. It may have maximum and minimum values.

A simple experiment will show that if 95 cubic centimeters of dry sand be mixed with 5 cubic centimeters of water the resulting mixture can not be put into a 100-cubic centimeter cylinder. The porosity of the sand has been increased by adding the water. A corresponding effect on resistance to flow of air is to be expected.

In Fig. 5 is shown graphically the effect of moisture content upon sands of uniform grain size. It is worthy of note that the moisture for maximum venting properties is not far different for sands differing widely in grain size. The author has not attempted to examine the mechanism of this effect of moisture in detail; it may be due either to an increase in the grain size, each grain being increased in radius by the thickness of the film of water at its surface or to the holding together by surface tension of many small damp grain being increased in radius. This phenomenon occurs to a limited extent in grains of pure silica so it is not solely due to the colloidal clay coating.

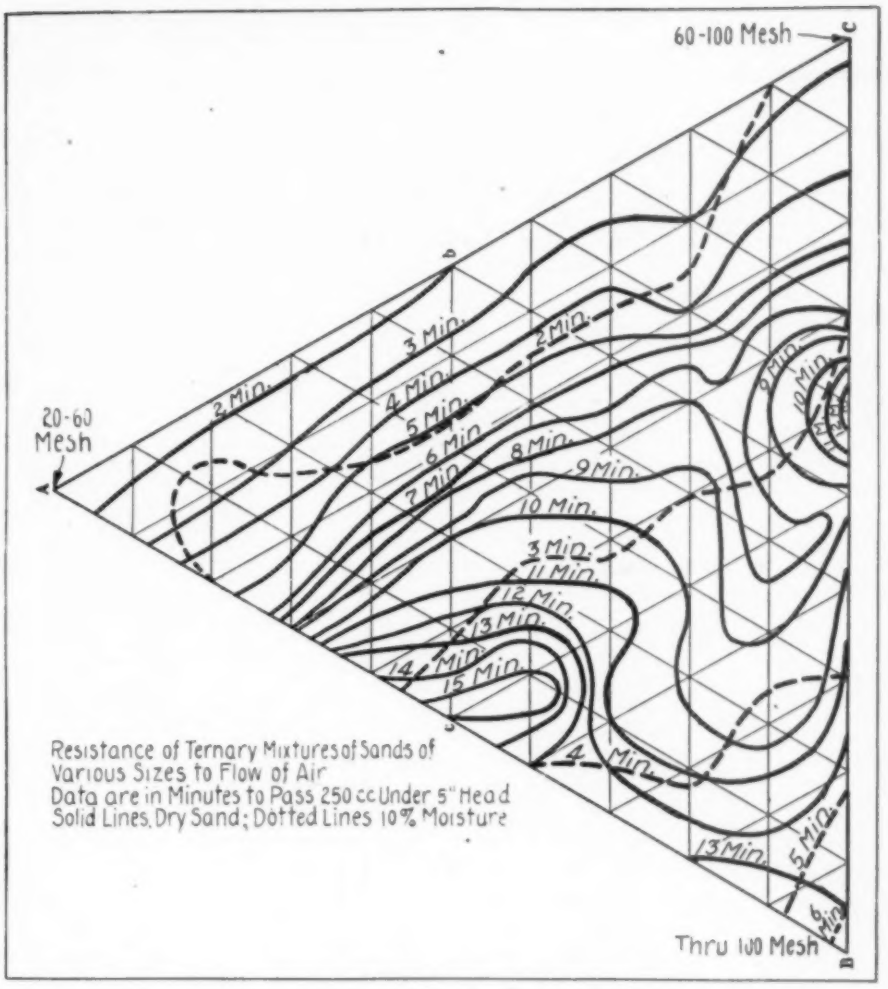

60-100 Mesh
20-60 Mesh
Thru 100 Mesh
Resistance of Ternary Mixtures of Sands of Various Sizes to Flow of Air
Data are in Minutes to Pass 250 cc Under 5" Head
Solid Lines, Dry Sand; Dotted Lines 10% Moisture

FIG. 7—RESISTANCE OF TERNARY MIXTURES TO FLOW OF AIR

Binary mixtures of sands of different grain size when damp behave somewhat similarly to the dry mixtures although the changes are not identical and usually less marked.

In Fig. 6 the resistance to flow through uniform grained fractures is plotted against grain size, a separate graph being shown for dry sand and for sand of 10 per cent moisture corresponding approximately to the point of maximum perviousness.

Data Not Directly Comparable

If ternary mixtures—mixtures of three grain sizes—are used, complex relationships occur. Any point within the triangle of Fig. 7 may represent the composition, by per cent, of a sand consisting of three grain sizes. The corners represent mixtures 100 per cent of a given size (one corner for each of the three sizes chosen). The binary mixtures are along the sides of the triangle and the ternary mixtures within it, the relative amounts of the three ingredients being in proportion to the distance of the point marking the mixture, from the three sides. The resistance to flow, in time per unit volume is shown by contour lines, all points in a given line having the same resistance. Lines are plotted for both dry and damp sand.

The data are not directly comparable with the binary graphs as the determinations were on two different sands. The figure will nevertheless show the exceeding complexity of any relation between sieve test and perviousness.

A note of caution should be inserted. It is clearly understood that the fractions taken as representing uniformity of grain are within themselves actually present in a gradation of sizes between the dimensions of two adjacent successive screens.

Had time and equipment permitted the preparation of fractions consisting of exactly equal grains in each fraction the inflections in the curves would become still further accentuated.

The experiment would be interesting but no practical gain would arise for the test for perviousness is more easily and cheaply made than the screen test and may be directly applied.

The following conclusions may be drawn:

Sands of absolutely uniform grain size are the most pervious.

The relation between grain size and perviousness of sands is too complicated to permit drawing any conclusions.

The perviousness can be readily and cheaply determined by direct experiment.

The sieve test of sand is of academic interest only and means practically nothing in a study of the commercial properties of molding sand.

The perviousness of molding sand depends on its moisture content and in the beginning increases with increase in moisture.

Electric Welding a Chilled Iron Roll

BY C. J. HOLSLAG

MANY people, including engineers, are under the impression that in the electric arc welding of cast iron the inserted studs are placed in the break for the purpose of entangling the metal of the weld with the parent metal. That in fact they correspond to the wooden skewers stuck into a piece of meat before it is placed in the oven, or that they function in the same manner as the pegs in a shoe. The correct design of studs and the theory of their use formed the subject of a paper presented by the author January 18, 1921 before the Metropolitan section of the American Welding Society, New York. The paper was published in the February, 1921 issue of the *Welding Engineer*.

The use of a copper-nickel alloy, either plain monel metal, or as we have found, one of its derivatives, with a copper nickel content, renders the process of welding cast iron cold, entirely feasible and does not leave any hard spots or layers. This alloy produces a weld with the strength of steel, but the deposited metal may include gas bubbles and pockets. To prevent this formation the welding must be done slowly and this feature together with the cost of the nickel electrode almost prohibits the process for large jobs. However, it has been found that this desirable alloy may be restricted to a few points on the weld and the remainder of the space may be filled with reasonably priced steel. Thus, the alloy may be sued to fill in the first layer, the last layer, the joints, or, a spot where a hole is to be drilled. In this manner the machineable qualities will be as desired and the weld will have all the rugged strength of steel welded to studded cast iron. Many of the theories on cast iron welding recently were carried into actual practice in the welding of a chilled cast iron roll.

The roll, 5 feet long, 22 inches diameter, was provided with a bearing 18 inches long, 14 inches diameter at each end and a gear extension on the end of each bearing about 15 inches long and 11 inches diameter. The break ocurred at the point where the neck joined the body of the roll. The broken surface was perfectly clean indicating that there was no defect in the iron and the accident evidently was caused by the roll becoming jammed while the remainder of the roll train was in motion. The roll was hollow, steam heated for rubber work and therefore the weld had to be steam tight as well as strong.

The smaller part was placed in the lathe and the broken end turned down approximately to a 54 degree angle. The main part of the shoulder was cut to approximate a V by the use of the electric arc with about 600 amperes. This made a nice chilled surface, even more chilled than the outside of the roll and rendered welding easy. However, the chilled surface had to be chipped in spots where the studs were placed later. Three rows of studs, staggered about 2½ to 3 inches apart, were inserted in each side of the V surface. With an electrode specially adopted for cast iron welding, each of these studs was merged into the face of the V before the parts were put together. The entire surface to be welded practically was covered with steel before starting to line up.

The body of the roll was set up on end and anchored firmly, then the upper part was lowered from a chain block and lined up by holding straight edges on two sides 90 degrees apart and drifting them around the circle until alignment was perfect. All welders will determine whether the job is, or is not, going to remain in line. In this case, due to the chilled surface there was no chance of remachining and the job had to be perfect at the conclusion of the welding operation. Two men, one on each side simultaneously made the first few deposits. The men worked 180 degrees apart and then 180 degrees apart again, but only 90 degrees from their first weld. After these first Vs were put in the two parts of the casting were found to be out of alignment by 3/32-inch. By welding on the side to be pulled down and by driving chisels on the opposite side the casting was pulled back straight at a time when enough metal was deposited and cooled to prevent any further distortion. From this point the job was comparatively easy and consisted in running beads around parallel to the circumference of the roll. The reason for running the beads parallel instead of across the break, is because of the lesser expansion and contraction of the width of the bead, compared with the length.

The gap was built up approximately to size with special steel electrodes. The edges were left open and filled in with a special copper-nickel electrode which has the property of being machineable when deposited cold. When the casting was set up in a lathe to true the bearings the extraneous welding metal was cut down to the original size of the casting. This job bears out several theories. Studding allows arc welding to really weld to the cast iron. If this weld had only engaged the steel studs the steam would have leaked at both joints. By the use of studs to make the stretch come in the steel instead of the cast iron, or along the edge of the joint, the weld held throughout. Chilled cast iron can be welded. Welding parallel instead of across the break to lessen the resultant expansion and contraction, worked out perfectly in this instance. The work was done by two men with all possible speed and with a 5/32-inch electrode and yet the chilled surface on the casting was not affected.

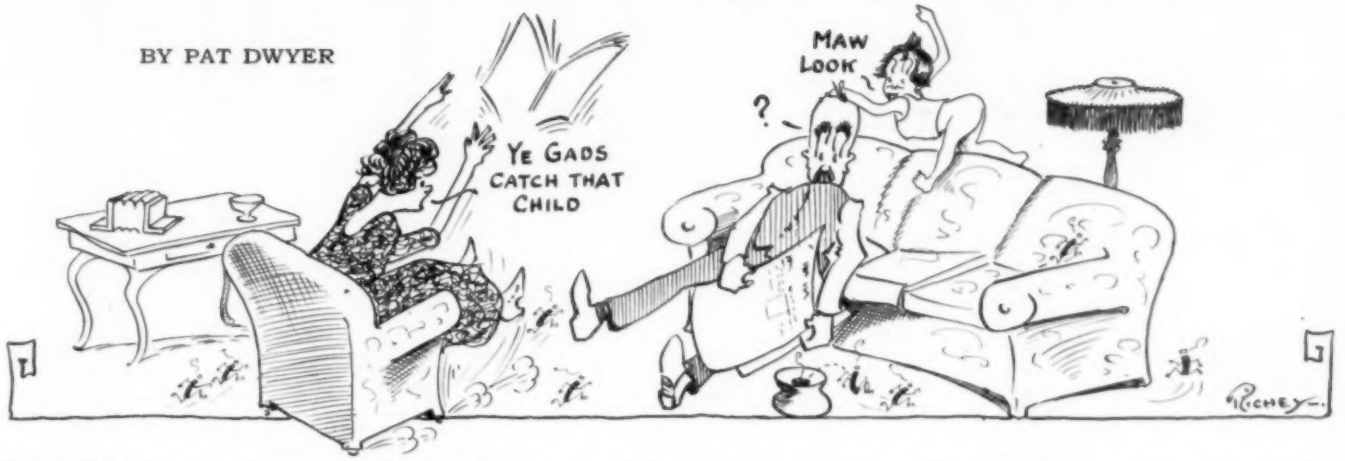
From the Journal of the American Welding Society for March, 1922.

Reprints Article on Zinc

The paper on The Effect of Impurities on the Oxidation and Swelling of Zinc-Aluminum Alloys presented by H. E. Brauer and W. M. Pierce at the joint meeting of the American Foundrymen's association and the institute of metals division of the American Institute of Mining and Metallurgical Engineers held at Rochester in June has been republished in pamphlet form by the New Jersey Zinc Co., 106 Front street, New York. This paper gives the results of tests on binary alloys made with zinc and aluminum, being illustrated with charts and numerous micrographs.

Bill Discusses Pulley Molding Problems—IV

BY PAT DWYER

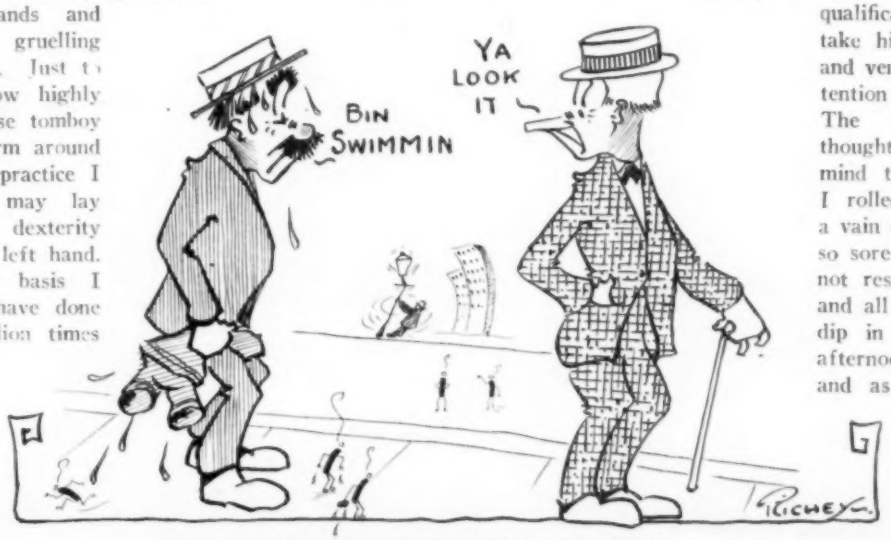


WE have not yet arrived at that state of affluence where a French governess takes the children to the ivory and old gold nursery, carefully removes and folds their clothes and tucks them in their little sandalwood cribs. Judging the future by the past, I am inclined to the opinion that by the time we are in a position to afford any luxuries of that character, the children will be quite competent to peel off what few clothes they have and jump into their own little iron cots. In fact they can do that now, with the exception of one little three-year old cherub who insists on being disrobed down stairs.

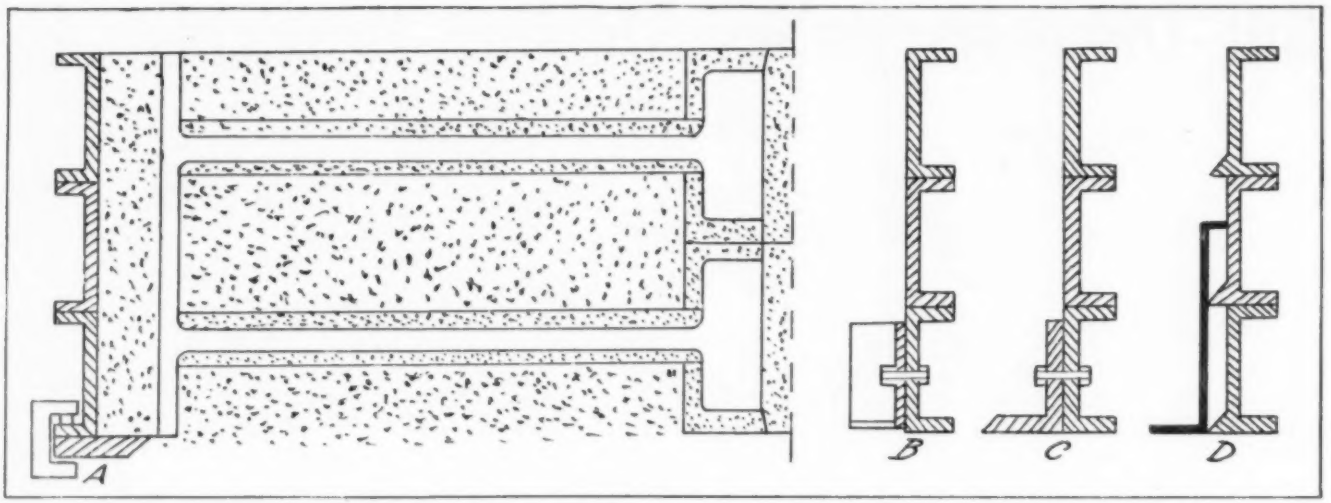
Clothed in one brief garment of the size and style worn by the little miss in the popular advertisements appearing in all the magazines a few years ago—the one in which the wearer bewails the fact that her mother did not use a certain brand of soap—she races back and forth across the room a few times before submitting to the restrictions of a night gown. Not content with making an adorable nuisance of herself in this manner, she climbs up on the arm of the chair in which I am trying to rest my poor tired hands and feet after the gruelling activities of the day. Just to convince her of how highly I disapprove of these tomboy tactics I curl one arm around her and from long practice I think I modestly may lay claim to equal dexterity with either right or left hand. On a conservative basis I should say that I have done this probably a million times and yet, on each occasion her mother considers it necessary to warn me to be careful and not let the child fall. If she would couch her admonition in kind and gentle language, tacitly admitting that I was able and willing, ready and anxious to defend the little lady against any and all forms of accident I should not mind; but apparently she is under the impression that I am in league with the hospital authorities and just waiting for a good chance to supply an interesting specimen of dislocation, or possibly compound fractures of one or more limbs. In no other way can I account for the totally unwarranted manner in which she warns me: "For heaven's sake, hold that child carefully; do you want her to fall in your smelly old cuspidor?" Silly question Number one, I calls it. To be strictly truthful I do not call it aloud.

If I was so minded I could quote her statistics by the yard to the effect that while it is true young ladies rarely fall into a man's arms, it equally is true that once there, they never fall out; but I am deterred by the fact that she is literal minded and probably would counter by asking me if I was quoting from my own experience. Any person over seven or who, in other words, has arrived at the age of reason, readily will realize what a deep, dark and bottomless trap lies ahead of a man who is silly enough to answer either "yes," or "no," to a question of that character. I passed the age of seven several years ago and in addition have had quite a few years of actual experience as a journeyman Benedict and strictly between ourselves, as one mere man to another, I never step forward four paces and salute when volunteers are called to start an argument. However, in the event that I am drafted I try and do my little bit.

Without for a moment admitting that I am in what the poets are pleased to refer to as the *scre and yellow leaf*, or that I am in need of a cane to assist me in creeping around from the chimney corner to the sunny spot on the front porch, still I find I have arrived at a time of life when I sometimes look back on the long trail and wonder among other things, if there is not some basis of truth in the well known claim that a special providence watches over children and fools. In justice to myself I should prefer to limit the application to children, but if I did, some hawkeye would be sure to note the qualification and forthwith take his trusty pen in hand and venomously direct my attention to the misquotation. The foregoing train of thought was started in my mind the other night while I rolled around the bed in a vain effort to sleep. I was so sore all over that I could not rest in any one position and all on account of a little dip in the lake during the afternoon. At various times and as far back as I can remember I have had that tired feeling, but so far as I know this was the first occasion I was too tired to



A LITTLE EXERCISE GOES A LONG WAY



FOUR ALTERNATIVE METHODS OF SUPPORTING THE SAND IN THE CHEEK OF A PULLEY MOLD

sleep. The combination of tired muscles and a mind drifting back through the years reminded me of what probably was the narrowest of many escapes from the allegorical old gentleman who goes around with a scythe gathering in the sheaves. On that occasion I more nearly approached the point of utter collapse than at any time either before or since and, as I said, the incident is one of many, personal and otherwise, supporting the contention about the special providence watching over children.

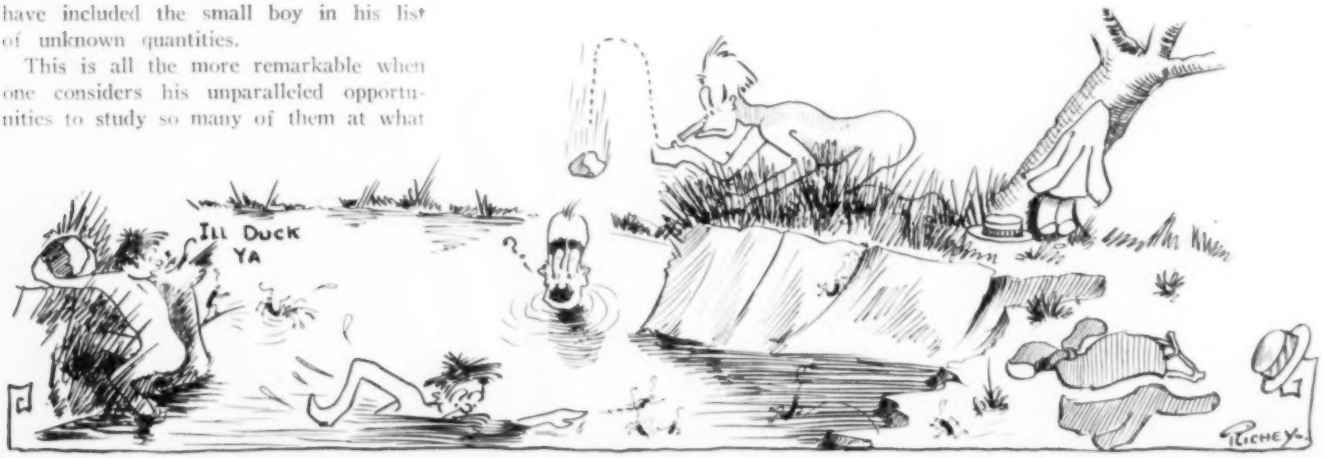
In the summer of my eleventh year and in company with many other young gentlemen of equally mature age, I spent the greater part of every day in a river that flowed through the old home town. I think it was Solomon who modestly admitted—and if it was not Solomon, who was it?—anyway it makes no material difference—that he could not understand three things, nay, four: The way of an eagle in the air, the way of a ship in the sea, the way of a serpent upon a rock, or the way of a man with a maid. During my youthful days I accepted Solomon's wisdom at its face value and did not think of questioning his omniscience, but in later years I sometimes have doubted his official batting average. He should have included the small boy in his list of unknown quantities.

This is all the more remarkable when one considers his unparalleled opportunities to study so many of them at what might be termed, close range. Without bothering their heads about the why or the wherefore, boys observe certain customs and play certain games at various seasons of the year. They shoot marbles, spin tops, fly kites and take up baseball in regular rotation, and it is a queer lad who does not recognize the sign of the two fingers as an invitation to go for a swim.

Through natural limitations imposed by increasing age, and I may as well admit, laziness, I am not as closely in touch with youthful activities as I was once upon a time and therefore I don't know if the custom still obtains of building a huge fire on the shore, even on days when the sun would blister the hide on an elephant. Why this custom and many others equally mysterious prevailed, I don't know and never did know, but the fact remains that to be allowed to swim with the gang, each boy had to gather his share of driftwood for the fire and no boy was considered a swimmer until he had crossed the river at high tide, under his own power and the critical eyes of at least two unbiased witnesses.

At low tide one could wade practically half across and then only have to swim across the channel, 10 to 15 feet deep and about 50 yards wide. At high tide the river was filled from bank to bank with salt water from 8 to 10 feet deep and correspondingly deeper over the channel. The distance did not constitute a world's record and the round trip without a stop in after years merely served as a preliminary or warming up exercise, but the trial trip certainly was an endurance test and usually when the boys arrived at the opposite shore and feebly dragged their little naked bodies up on the bank, there wasn't a gasp left in them. The risk of drowning attached to this exercise never seemed to enter any person's mind, and in all justice it must be admitted that the results justified their faith, or their ignorance, but I have marvelled many times in later years, why at least 50 per cent of the boys were not drowned.

I met Bill the day after this swimming party which left me so sore I could not sleep, and naturally the talk drifted back to the old days when bathing suits were unknown, where the tang of salt was in the air and where the gang played "follow the leader" out to the end of the spring board and hopped off, head or feet first, into the



BOYS WILL BE BOYS INNOCENT GAMES AND PASTIMES REMINISCENT OF THE OLD SWIMMIN' HOLE

HEAT REQUIRED TO MELT AND SUPERHEAT ALUMINUM

(Concluded from Data Sheet No. 444)

For the purpose of an example in calculating the amount of heat necessary to superheat aluminum it is assumed that the metal is to be raised to 800 degrees Cent. The formula

$$W = t + Sm\ (0—t) + R + (t'—t)\ S\ liquid$$

may be used,

where W = total heat required in gram calories,
T = melting point in degrees Cent. from zero,
Sm (0—t) = mean specific heat between 0 degrees and t degrees,
R = latent heat of fusion in gram calories,
t' = temperature heated above t, and
S liquid = mean specific heat in the liquid state.

Since for practical purposes, the information wanted in the amount of heat required to raise aluminum from 25 degrees to 800 degrees Cent., and remembering that the heat required to raise the metal from 25 degrees to the melting point was 243.9 calories, then it is only necessary to add to this the amount of heat required to raise the metal from 658.7 degrees to 800 degrees Cent.

Substituting in the last part of the formula, (t'—t) S liquid, the figures are

(800—658.7) 0.308 = 43.5 calories,

and adding this to 243.9, it follows that 287.4 calories per gram are required.

287.4 x 1.8 = 517 B.t.u. per pound

The table below gives in the center column the calorific value of different fuels, and in the column at the right the amount of fuel required to melt and superheat aluminum at 800 degrees Cent. These values are calculated on the basis of 517 B.t.u. per pound of aluminum required. No allowance is made for furnace losses, but the values are figured on 100 per cent efficiency of melti ng operations.

Fuel	Calorific value in B.t.u.	Amount of fuel required to melt and superheat 100 pounds aluminum at 800 degrees Cent.
Bituminous coal	12,000 per pound	4.3 pounds
Anthracite coal	14,000 per pound	3.7 pounds
Metallurgical coke	13,000 per pound	4.0 pounds
Natural gas	900 per cubic feet	57.4 cubic feet
Illuminating (city) gas	600 per cubic feet	86.2 cubic feet
Producer gas	125 per cubic feet	431.0 cubic feet
Fuel oil	19,000 per pound	2.7 pounds

DATA ON ALUMINUM ALLOYS

The mechanical properties of the alloys of aluminum and zinc are improved by the addition of small percentages of copper as shown by the following mechanical properties of the two alloys.

Alloy—Aluminum 85 per cent; zinc 15 per cent.

SAND CAST BARS

Yield Point, lbs. per sq. in.	Ultimate Strength, lbs. per sq. in.	Elongation, per cent in 2 in.
21,504	24,864	2.0

CHILL CAST BARS

Yield Point, lbs. per sq. in.	Ultimate Strength, lbs. per sq. in.	Elongation, per cent in 2 in.
12,992	26,208	8.5

Alloy—Aluminum 82 per cent; zinc 15 per cent; copper 3 per cent.

SAND CAST BARS

Yield Point, lbs. per sq. in.	Ultimate Strength, lbs. per sq. in.	Elongation, per cent in 2 in.
21,952	32,256	3.0

CHILL CAST BARS

Yield Point, lbs. per sq. in.	Ultimate Strength, lbs. per sq. in.	Elongation, per cent in 2 in.
15,680	31,136	6.5

In comparing the tensile strength of alloys of aluminum and zinc it is important to remember that an increase of zinc content brings with it also a corresponding increase of density. Therefore the relative merits of the various alloys are to be gaged in terms of their specific tenacity, a term defined as being measured by the ratio of tensile strength to weight per unit volume. The maximum specific tenacity is reached in the neighborhood of 25 per cent of zinc, both when sand cast and when chill cast.

Data concerning the properties of aluminum-zinc and aluminum-zinc-copper alloys given by W. Rosenhain in the course of the second Cantor lecture before the Royal Society of Arts, April, 1920.

Note—This sheet maybe cut into two sections 5x7 inches, and may be readily bound in note book form.

THE FOUNDRY DATA SHEET, SEPTEMBER 15, 1922
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

transparent green water. I asked him if he had any theory to account for the small boy's apparent immunity from accident and intimated further that although I had been a boy and now had boys of my own I still was at a loss to know why they did certain things.

"I can't account for their immunity from accident," said Bill, "in fact, when I think of all the snares, traps and pitfalls strewed along the path of life, I am moved to wonder how the race survives, but as to why they do certain things, that is an easy one. Man is a creature of habit and while there may be a reason for adopting a certain custom he will continue observing the custom, sometimes for centuries after the reason no longer is in existence. Consider the buttons on the sleeves of a man's coat. About 150 years ago a dapper commanding officer had his sensibilities shocked by the sight of his soldiers wiping their noses on their coat sleeves. Instead of issuing a general order forbidding this quaint and homely custom, he had the regimental tailor sew a few brass buttons over the contact area on both right and left sleeves. Primarily, the buttons were sewed on both sleeves in the interests of military harmony, symmetry and mathematical regularity, but they also served to prevent any southpaw from warming up or otherwise enjoying any undue advantage. The necessity for these precautionary measures long since has passed away, even the soldiers' tunics no longer are decorated in this manner, but the civilians, who only aped the military in the early days, still carry these useless barnacles on their coat sleeves.

"Habit and custom are hard masters to escape and that is why you see a foundry sticking to one method of making certain castings when perhaps half a dozen methods are feasible. Where a considerable amount of rigging may be involved a foundry may be justified in retaining a certain method in preference to others, but it is well for a foundryman to familiarize himself with every method. He is then in a position to maintain an open mind and when a question of the relative merits of several methods arises in connection with any given job he is qualified to make an intelligent selection. For example, consider the many methods practiced for making pulley wheels. On former occasions I have touched lightly on a few of these, but so far have said nothing on what probably is the most commonly employed where only one or two castings are required. Even this method has its modifications depending on the style of flask available.

"Assuming that the wheel is to be 8 feet diameter, 3 feet face and provided with a double set of arms, usually the most economical method for making it is to cheek off the outside and form the arms and hubs in dry-sand cores. The pattern requirements will be reduced to a minimum inasmuch as all that will be required will be a sweep for the inside, one for the outside, a corebox for the hub and a short segment formed on the bandsaw for imparting a bevel edge to the open sand lifting ring. The lifting ring is made first to have it ready by the time it is wanted.

"Allowing for finish and contraction, the mold for an 8-foot wheel will be 8 feet 15/8 inches in diameter and therefore when setting the trammels for the inside of the lifting ring it will be necessary to bear this fact in mind. Two inches, one on each side, are added for clearance and then an additional 1¾ inches for the contraction of the ring while *it* is cooling. Altogether, the trammels will be set to half a total diameter of 8 feet 5¾ inches, or 4 feet 2⅞ inches. In many places it is customary for the patternmaker to do all the measuring on his shrink rule and supply the molder with a long stick on which the points at which he is to set his trammels are indicated. This plan has its advantages but I think every molder should be familiar with the tricky little problems involved in the contraction of metal, and competent to do all his own measuring, at least in connection with the preparation of foundry rigging.

"Having set the trammels to the proper diameter a ring is scribed on an open sand bed, then the trammel points are shifted to correspond to the radius of the flask to be employed on the job and a second ring, the diameter of the flask plus contraction, is also struck on the bed. A piece of board, not necessarily the full width of the lifting plate, plain on the outer edge and beveled on the inner edge, is employed as a guide in making up the boundaries of the mold for the lifting plate. Four lugs are formed at four equidistant points to serve as guides for the stakes.

"In making the pulley mold the cheek is swept first, lifted out of the way until the interior part of the mold is formed, then it is returned to place and the mold is poured. Although the procedure may be summed up thus briefly, many interesting features present themselves as the work progresses and unless they are handled intelligently they may interfere with the proper assembling of the mold. At the very beginning it is necessary to see that the spindle is set absolutely perpendicular, otherwise trouble will be experienced in lowering the cheek back to place. Where a great deal of sweep work is done the spindle seats are fixed permanently and the molder does not have to concern himself with problems of that character. Where a mold only is swept occasionally, the spindle is set up temporarily and while in a few instances a mold may be made from a spindle that is not absolutely perpendicular the careful molder will plumb his spindle before starting any job.

"After the spindle has been set a straight sweep is attached to the arm and used to sweep a level bed on the floor a little larger in diameter than the lifting plate. Usually a straightedge is available for this purpose so that it is not necessary to make a special sweep. The lifting plate is lowered on to the bed, centered from the spindle, rapped down firmly and staked at the four lugs. Sand is filled in all the way across and butted off lightly, then the straight sweep, shifted a little higher on the spindle again is employed to scrape the sand off flush with the upper surface of the lifting plate.

"The straight sweep is removed and replaced by the special sweep designed to form the outside face of the mold. Great care is required to set it accurately, otherwise the thickness of the rim will not be uniform. In this connection it will be well to remember that the greatest strain will be exerted at the bottom of the mold and therefore the bottom edge of the sweep will be set at least ⅛ inch closer to the spindle than the top. This taper in the sweep corresponds to some extent to the taper on a pattern. The flasks are lowered on to the plate and a section of boiler plate, or any other suitable device, bent to the required shape, is employed as a support against which to ram the sand to the top of the flask. The boiler plate usually a short section one-sixth of the circumference, or less, is moved around successively until the entire ring has been formed. It is then removed and the sweep is moved around several times until the face of the mold is smooth and even. The upper edge is formed by a short shoulder on the sweep. A short wood segment about 2 feet long, band sawed to the proper circumference and laid on the edge, serves as a guide in forming a nice firm edge around the top. The cheek then is lifted off and finished, black washed and dried, and the interior part of the mold containing the arm and hub cores is built up in the manner described in the preceding number of this series."

"Well Bill," I said, "you certainly can ramble further away from the point at issue than any other person I know. I ask you for your opinion on why more little boys are not drowned while learning to swim and you blissfully wander off into the depths of a foundry to watch some hairy molder sweeping up a pulley."

"I don't pretend to know everything," said Bill. "But I am willing to hazard an opinion why one member of your gang —and I am not excepting present company—did not drown. Any person full of wind and soap suds like a barber's cat stands about as much chance of sinking as a rubber balloon."

How and Why in Brass Founding

By Charles Vickers

Cold Metal Responsible for Bad Castings

We are using an alloy, copper 85 per cent, tin, 5 per cent; lead, 5 per cent, and zinc, 5 per cent in the manufacture of various steam metal castings, and experience difficulty occasionally due to holes that appear in the castings under the gates. Is the size of the gate, or the temperature at which the metal is poured responsible for this condition?

Either too small a gate or too low a pouring temperature will produce the condition complained of. When there is only a certain percentage of these defective castings, it may be assumed the molds poured first with the hotter metal came sound, and the defectives were poured at the end of the heat when the metal was cooler. In such a case pouring fewer molds with smaller pots would remedy the difficulty. There always is a limit to the number of molds that can be economically poured at a heat, and the smaller the castings, the quicker this limit is reached.

The difficulty frequently can be remedied by molding a runner in the cope part of the molds. As a general rule, 2 pounds of metal has to be melted for every pound of castings obtained and in the case of small castings, it will often be 3 pounds melted to 1 pound of castings. Some foundry foremen imagine they can beat this rule, but when results are studied it will be found how incorrect this idea really is. A small gate entering a casting can be prevented from *drawing* by a runner properly arranged with a view of acting as a feeder, also, the height of the sprue may have a great deal to do with the matter. We suggest the major part of the runners be placed in the scope, the sprue be raised, and the metal never be poured when it is dull and sluggish, and it will be found the production loss due to draw holes will cease.

Deoxidizer To Be Used With Monel Metal

We find that our monel metal castings always contain pinholes. We use dry sand molds and melt the metal in an ordinary coke fired furnace. Do you think the fault lies in our sand or mixture of metal?

The pinholes can be avoided by the use of a deoxidizer. An alloy of nickel and magnesium is used for this purpose with fair success, although there is no reason why an alloy of copper and magnesium could not be used. Another deoxidizer frequently used is manganese copper, in connection with magnesium, and the combination of manganese and magnesium works quite well. The composition of the alloy cannot be changed and still have it remain monel metal; it may vary within small limits but should contain approximately 28 per cent copper; 67 per cent nickel, about 2.5 per cent iron and small amounts of other elements. Where manganese is present as a constituent of the alloy, use magnesium as a deoxidizer, for a further small addition of manganese could not be expected to do much good.

The molding sand should be as refractory as possible. It must not fuse onto the castings.

Scrap Mixture for Fire Hose Couplings

We would appreciate a formula of brass for making firehose couplings that must stand about 500 pounds pressure. What we want is a mixture using mostly scrap metals.

Select such scrap as old valves and faucets and melt them with a liberal covering of charcoal; just before pulling the pot from the fire, stir well and add one ounce of phosphor copper, again stir and pour at an orange heat. Aluminum must be rigidly excluded from the mixture, and the scrap should be hand picked. In sorting the scrap if any pieces are found that appear doubtful, break them and examine the fractured surfaces. If red specks and differently colored crystals are seen, reserve the scrap for other and less important work.

For new metal the following mixture is suitable:

Fire Hose Couplings

	Pounds
Copper	83
Zinc	11
Lead	4
Tin	2

Unless the scrap metals are considerably cheaper a mixture of new metal should be preferred.

Lead and Aluminum Do Not Mix Readily

We would like to know how to make an alloy of lead and aluminum; also what can be added to lead to make a comparatively strong casting.

Lead and aluminum alloy only to a small extent even where lead to the amount of several per cent is added to molten aluminum the resulting alloy will contain approximately 1 per cent lead every time it is tried. Certain people claim they can get 10 per cent lead into aluminum alloys, but while willing to admit that 10 per cent may have been added the analytical chemist will experience trouble in finding half that amount. If a controversy arose between the chemist and the maker of the alloy, we would align with the chemist. What the analytical chemist *can't find* in an alloy, in 98 cases out of 100 isn't there.

Profound thinkers have stated that lead can be alloyed with aluminum, provided it is added as oxide (litharge). The theory is that the heat of the aluminum reduces the oxide to lead. Why it should alloy under such circumstances is exceedingly difficult to understand, but it might happen. Thermit reactions between aluminum and such oxides as copper oxide, lead oxide, and so forth, unless handled skillfully, are dangerous and we do not recommend such experiments in brass foundries. A better method would be to add the lead to the aluminum and stir it in. Sometimes a copper-lead alloy is used as the hardener, and according to some experts this is a good way to add the lead. To harden lead for small castings add 13 per cent antimony.

Heated Sulphuric Acid Attacks Aluminum

We would like to know what effect sulphuric acid will have on cast aluminum.

Sulphuric acid when diluted with water has little effect on cast aluminum when cold, but when heated it readily attacks it. Therefore, it is not advisable to use aluminum in situations where it will be continually exposed to this acid. For such purpose a cast iron containing between twelve and fourteen per cent of silicon is the best.

Increase in Foundries Shown

Recently Completed Statistics Demonstrate an Advance in the Total Number of Castings Plants in the United States and Canada—Steel Foundries Only Branch Showing a Loss

STATISTICS just completed for THE FOUNDRY indicate that in the past two years the total number of foundries in both the United States and Canada have increased. In November, 1920, the total number of castings plants was given as 6516, while on Sept. 1, 1922, this had been increased to 6733, of which 6181 are in the United States and 552 in Canada. This growth of 217 shops in two years, shows only slightly more strongly in the gray iron foundries which have increased in the two countries from 4857 in 1920 to 4966 at the present time, giving a gain of 109. Brass foundries under the same classifications have increased from 3482 to 3542; while malleable foundries have increased from 267 to 274; and steel foundries have dropped from 449 to 409 as these reports indicate.

In the United States alone, the total number of foundries shown this year is 199 ahead of 1920. This gain, also, is registered slightly higher in the gray iron shops, which at present total 4508, while two years ago, 4397 were shown. The number of brass shops in 1920 was given as 3163, while at present this is shown to be 3217, indicating a gain of 54. Malleable foundries in the United States alone have gone ahead from 242 to 251, while steel foundries have dropped 30, from 409 to 379. Foundries melting aluminum, in many cases shops casting other metals, which have added aluminum departments have shown the most remarkable gain. In 1920, the total reported in the United States was 2169, while the recent count shows 2500, giving a gain of 331. In Canada, the total of foundries melting aluminum increased from 194 to 253; giving a grand total of 2753 for 1922 as compared with 2363 two years ago. The difference is 390.

The decrease in steel foundries from a grand total of 449 in 1920 to 440 this year, is reflected in the reports of

Following Through

WHEN a molder first is taught to mix a heap of sand he is shown how a full clean swing of the shovel with a fillip of the handle at the end causes the burden to spread fan-like with the maximum benefit to the properties of the sand. In other words he learns the value of following through. *Perhaps that same law applied to individual activities might govern in the collective business life of the industry. This would account for the increase in foundries apparent between the years* 1922 *and* 1920 *when the last previous statistics were compiled by* THE FOUNDRY. *The impetus given during the prosperous period just preceding no doubt saw many plants projected which were completed despite the depression which entered late in* 1920. *This would account for the totals shown.*

TOTAL NUMBER OF FOUNDRIES IN THE UNITED STATES AND CANADA, SEPT. 1, 1922

TOTAL FOUNDRIES IN THE UNITED STATES AND CANADA, 1920

GRAY IRON FOUNDRIES IN THE UNITED STATES AND CANADA, SEPT. 1, 1922

MALLEABLE FOUNDRIES IN THE UNITED STATES AND CANADA, SEPT. 1, 1922

steel shops using electric furnaces for melting. The total number of these reported in 1920 was 206, while the recent census shows a decrease of 4 to 202. Of this number two less were reported in Canada, decreasing from 21 to 19 and 2 were lost to the United States, decreasing from 185 to 183.

A study of the reports from the different states furnishes some interesting information. Pennsylvania, although still retaining the lead, shows a loss in the total number of foundries in the state. In 1920, 803 were noted, while the recent figures give 775.

Table I

Iron and Steel Foundries 1920-1922

Total Foundries in the United States and Canada, 1922-1920	
United States and Canada, 1922	6733
United States and Canada, 1920	6516
Total foundries, gain	217
Foundries, United States, 1922	6181
Foundries, United States, 1920	5982
Gain in United States	199
Foundries in Canada, 1922	552
Foundries in Canada, 1920	534
Gain in Canada	18
Gray Iron Foundries in the United States and Canada, 1922 and 1920	
United States and Canada, 1922	4966
United States and Canada, 1920	4857
Total gray iron increase	109
Gray iron, United States, 1922	4508
Gray iron, United States, 1920	4397
Increase in the United States	111
Gray iron, Canada, 1922	458
Gray iron, Canada, 1920	460
Decrease in Canada	2
Malleable Foundries in the United States and Canada, 1922 and 1920	
United States and Canada, 1922	274
United States and Canada, 1920	268
Increase	6
United States, 1922	251
United States, 1920	242
Increase	9
Canada, 1922	23
Canada, 1920	26
Decrease	3
Steel Foundries in the United States and Canada, 1922 and 1920	
United States and Canada, 1922	409
United States and Canada, 1920	449
Decrease	40
United States, 1922	379
United States, 1920	409
Decrease	30
Canada, 1922	30
Canada, 1920	40
Decrease	10
Electric Steel Foundries in the United States and Canada, 1922 and 1920	
United States and Canada, 1922	202
United States and Canada, 1920	206
Decrease	4
United States, 1922	183
United States, 1920	185
Decrease	2
Canada, 1922	19
Canada, 1920	21
Decrease	2

However, this total still gives a marked lead over the second state in the list, Ohio with a total of 683 shops at the present time, while two years ago, 688 were noted. New York still is third, registering a gain of 11 foundries from 582 to 593 at the present time. The other leading states with their 1922 total shops are as follows: Illinois, fourth, 523; Michigan, fifth, 423; Wisconsin, sixth, 310; and Massachusetts seventh with 281.

Table II

Nonferrous Foundries 1920-1922

Total Exclusive Brass Foundries and Brass Departments of Other Plants in the United States and Canada, 1922 and 1920

United States and Canada, 1922.....	3542
United States and Canada, 1920.....	3482
Increase	60
Total brass, United States, 1922.....	3217
Total brass, United States, 1920.....	3163
Increase	54
Total brass, Canada, 1922.....	325
Total brass, Canada, 1920.....	319
Increase	6

Exclusive Brass Foundries in the United States and Canada, 1922 and 1920

United States and Canada, 1922.....	1391
United States and Canada, 1920.....	1316
Increase	75
Exclusive brass, United States, 1922..	1325
Exclusive brass, United States, 1920..	1263
Increase	62
Exclusive brass, Canada, 1922.....	66
Exclusive brass, Canada, 1920.....	53
Increase	13

Brass Departments of Gray Iron, Malleable and Steel Foundries in the United States and Canada, 1922-1920

United States and Canada, 1922.....	2151
United States and Canada, 1920.....	2167
Decrease	16
Brass departments, United States, 1922	1892
Brass departments, United States, 1920	1901
Decrease	9
Brass departments, Canada, 1922.....	259
Brass departments, Canada, 1920.....	266
Decrease	7

Foundries Melting Aluminum in the United States and Canada, 1922-1920

United States and Canada, 1922.....	2753
United States and Canada, 1920.....	2363
Increase	390
United States, 1922.....	2500
United States, 1920.....	2169
Increase	331
Canada, 1922	253
Canada, 1920	194
Increase	59

Illinois which showed an exceptional gain of 15.5 per cent during the period from 1918 to 1920, again shows a marked advance in the foundry industry, having increased 39 from a total of 484 to 523 registering a gain of 8.1 per cent during the two-year period just passed.

The Southern states, with but few exceptions, have shown an improvement in the total number of castings

STEEL FOUNDRIES IN THE UNITED STATES AND CANADA, SEPT. 1, 1922

EXCLUSIVE BRASS FOUNDRIES IN THE UNITED STATES AND CANADA, 1922

TOTAL BRASS FOUNDRIES IN THE UNITED STATES AND CANADA, 1922

Table III

Foundries of the United States and Canada in 1922 and 1920 by States and Provinces

UNITED STATES

	Total foundries 1922	Total foundries 1920	Increase or decrease in two years	Gray iron foundries 1922	Gray iron foundries 1920	Exclusive brass foundries 1922	Exclusive brass foundries 1920	Brass foundries departments of other shops 1922	Brass foundries departments of other shops 1920	Total brass foundries 1922	Total brass foundries 1920	Malleable iron foundries 1922	Malleable iron foundries 1920	Steel foundries 1922	Steel foundries 1920	Foundries melting aluminum 1922	Foundries melting aluminum 1920	Electric steel foundries 1922	Electric steel foundries 1920
Alabama	99	95	+ 4	98	88	2	5	30	34	32	39	2	3	6	5	22	21	2	2
Alaska	2	2	...	2	2	..	..	1	1	1	1	..	..	1	1	..	..	1	1
Arizona	8	9	— 1	8	9	..	..	8	9	8	9	1	..	..	1	4	4	..	..
Arkansas	19	23	— 4	18	20	1	3	14	15	15	18	..	..	1	1	8	11	1	1
California	226	182	+ 44	148	126	59	50	77	74	136	124	5	4	23	19	116	97	19	11
Canal Zone	1	1	...	1	1	..	..	1	1	1	1	..	..	1	1	1	1	..	..
Colorado	49	42	+ 7	30	33	13	8	15	19	28	27	..	..	5	5	22	17	3	4
Connecticut	187	177	+ 10	96	97	72	65	44	39	116	104	14	14	7	5	78	72	3	4
Delaware	16	17	— 1	7	6	6	8	6	5	12	13	1	1	4	4	7	6	2	..
Dist. of Columbia	9	8	+ 1	7	6	2	2	5	3	7	5	..	..	2	3	6	5	1	2
Florida	26	21	+ 5	23	20	3	1	21	20	24	21	1	1	..	..	25	19	..	..
Georgia	81	81	...	76	76	5	5	52	50	57	55	..	..	2	2	41	35	1	1
Hawaii	4	4	...	4	4	..	..	4	3	4	3	..	..	..	..	..	1	..	..
Idaho	9	8	+ 1	9	8	..	..	9	8	9	8	..	..	..	..	8	8	..	..
Illinois	523	484	+ 39	328	328	123	120	101	90	224	210	38	31	25	26	202	179	15	11
Indiana	252	242	+ 10	188	181	42	44	62	69	104	113	19	17	11	11	86	72	3	6
Iowa	110	110	...	95	96	9	8	42	46	51	54	1	3	6	7	49	43	3	3
Kansas	48	46	+ 2	45	42	2	3	27	30	29	33	1	2	..	1	29	28	..	..
Kentucky	55	55	...	41	41	12	14	16	15	28	29	1	..	2	1	19	19	..	..
Louisiana	36	34	+ 2	29	29	7	5	20	20	27	25	..	1	3	3	16	13	1	1
Maine	38	37	+ 1	34	30	4	7	25	23	29	30	..	..	..	..	15	15	..	..
Maryland	60	63	— 3	42	44	18	18	23	24	41	42	1	1	..	4	27	23	..	1
Massachusetts	281	263	+ 18	173	165	92	88	57	55	149	143	3	3	16	17	120	99	8	7
Michigan	423	388	+ 35	263	253	122	108	90	82	212	190	19	17	15	18	172	133	6	8
Minnesota	119	107	+ 12	95	91	19	13	50	49	69	62	1	2	8	9	59	48	3	4
Mississippi	22	17	+ 5	22	17	..	..	22	17	22	17	..	..	..	..	11	7	..	..
Missouri	143	133	+ 10	197	105	37	27	36	44	73	71	6	6	5	5	64	50	2	1
Montana	13	12	+ 1	13	12	..	..	12	11	12	11	..	..	..	..	8	7	..	..
Nebraska	34	32	+ 2	29	28	5	4	20	19	25	23	..	1	2	2	25	21	1	1
Nevada	4	4	...	3	3	1	1	3	3	4	4	..	..	..	..	3	3	..	..
New Hampshire	31	34	— 3	26	29	5	5	14	16	19	21	1	1	1	1	16	16	1	1
New Jersey	231	223	+ 8	154	153	67	61	52	53	119	114	6	8	7	7	94	78	1	2
New Mexico	2	2	...	2	2	..	..	2	2	2	2	..	..	..	..	2	2	..	..
New York	593	582	+ 11	386	399	162	151	169	180	331	331	28	29	19	28	239	203	10	16
North Carolina	74	73	+ 1	73	72	1	1	57	51	58	52	1	2	1	1	50	39	..	1
North Dakota	2	2	...	2	2	..	..	1	1	1	1	..	..	..	..	1	1	..	..
Ohio	683	688	— 5	455	464	170	176	107	123	277	299	37	42	52	52	208	193	30	27
Oklahoma	38	35	+ 3	32	31	5	3	22	20	27	23	1	1	2	3	23	18	1	2
Oregon	50	50	...	44	44	4	4	24	28	28	32	1	1	4	7	26	24	2	3
Pennsylvania	775	803	— 28	574	606	130	143	213	209	343	352	28	24	93	100	235	229	30	31
Rhode Island	45	43	+ 2	28	27	14	13	8	11	22	24	1	1	1	1	20	20	1	..
South Carolina	20	21	— 1	19	21	..	..	18	19	18	19	..	..	1	1	13	12	..	1
South Dakota	7	6	+ 1	6	6	1	..	4	3	5	3	..	..	..	..	4	3	..	..
Tennessee	74	77	— 3	70	72	5	5	30	34	35	39	1	1	2	2	27	27	..	..
Texas	72	68	+ 4	59	56	13	12	38	38	51	50	..	1	4	5	39	33	2	3
Utah	22	21	+ 1	20	21	2	..	16	15	18	15	..	..	2	2	15	9	1	1
Vermont	27	26	+ 1	25	25	2	2	14	14	16	16	..	..	..	..	14	11	..	..
Virginia	89	92	— 3	87	89	2	3	63	63	65	65	2	3	6	7	44	43	3	5
Washington	81	77	+ 4	65	62	13	12	40	36	53	48	1	..	10	12	44	40	9	10
West Virginia	56	53	+ 3	44	44	9	6	26	27	35	33	1	1	4	4	26	19	2	..
Wisconsin	310	307	+ 3	212	210	63	58	80	79	143	137	28	20	25	25	116	91	15	13
Wyoming	2	2	...	1	1	1	1	1	1	2	2	..	..	..	..	1	1	..	..
Total in U. S.	6181	5982	+199	4508	4397	1325	1263	1892	1901	3217	3163	251	242	379	409	2500	2169	183	185

CANADA

Alberta	16	17	— 1	13	16	3	1	13	15	16	16	1	..	..	3	14	11	..	1
British Columbia	33	33	— 2	26	30	4	1	19	24	23	25	..	2	2	3	19	11	2	3
Manitoba	15	16	— 1	12	13	2	1	6	7	8	8	..	..	1	1	8	7	1	1
New Brunswick	20	19	+ 1	18	17	2	2	13	15	15	17	..	..	..	1	10	9	..	..
Newfoundland	2	2	...	2	2	..	..	1	1	1	1	..	..	..	..	1	1	..	..
Nova Scotia	30	30	...	29	30	..	..	20	22	20	22	2	1	3	2	8	10	1	..
Ontario	327	310	+ 17	264	259	43	38	131	125	174	163	15	17	10	13	140	100	4	9
Prince Edward Island	3	2	+ 1	3	2	..	..	2	2	2	2	..	..	..	..	1	1	..	..
Quebec	104	100	+ 4	87	87	12	10	50	50	62	60	5	5	14	16	48	39	11	6
Saskatchewan	4	5	— 1	4	5	..	..	4	5	4	5	..	..	..	1	4	4	..	1
St. Pierre Et Miquelon	..	..	...	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..
Total in Canada	552	534	+ 18	453	463	67	53	259	276	325	319	23	26	30	40	253	194	19	21
Total in U. S. and Canada	6733	6516	+217	4966	4857	1391	1316	2151	2167	3542	3482	274	268	409	449	2753	2363	202	206

plants. Alabama, which from its iron production might be expected to lead shows a total of 99, an increase of 4 shops. Louisiana, Texas, Oklahoma, North Carolina, West Virginia and Florida all show a few more foundries than were reported two years ago.

Among the New England states, Massachusetts shows the greatest gain, increasing from 263 to 281 foundries; while Connecticut, Vermont, Maine and Rhode Island all have gone forward. New Hampshire shows only 3 plants less than two years ago.

Among the Canadian provinces, Ontario still maintains a long lead with a total of 310 as compared with 319 foundries two years ago. Quebec is second with 100 as compared to 102; while British Columbia has risen into third place with a total of 33 at present compared with 27 two years ago, Nova Scotia dropping from 34 to 30.

The gray iron foundry order closely parallels the standing of the states in the total number of foundries reported. Pennsylvania leads with 574; Ohio is second with 455; New York is third with 386; Illinois is fourth with 328; Michigan is fifth with 263; and Wisconsin is sixth with 212.

In Canada, Ontario has the greatest number of gray iron plants, showing a total of 264, while Quebec has 87; Nova Scotia, 29 and British Columbia, 26. It will be noted that the order of rank in the latter two mentioned provinces is reversed from that shown in the total number of foundries. British Columbia's greatest gain was represented in foundries melting aluminum and a slight gain is shown in the number of exclusive brass foundries.

The ranking importance of the states measured in terms of the total number of brass foundries shows no change over the two year period just passed. Pennsylvania leads with a total of 343; New York is second with 331; Ohio is third with 277. The others which follow are: Illinois, fourth, 224; Michigan, fifth, 212; Massachusetts, sixth, 149; and Wisconsin, seventh with 143.

A greater change is noted in the distribution of malleable foundries. At the time of the last census Ohio was ahead with 42 malleable shops. At present, Illinois is in the lead with 38. Ohio drops into second place with 37; New York, Pennsylvania and Wisconsin each have 28; while Michigan and Indiana each report 19 malleable plants. The increase in the total number of malleable foundries from 268 to 274 is marked by a growth of 9 in the total number in the United States and a loss of 3 in Canada.

No marked change in the standing of the states as steel castings producers is noted. Except for the loss in the total number of steel foundries, the most noteworthy feature is the continued advance of California in the ranks. An increase from 19 to 23 in the total number of steel foundries in the latter state places it in fourth place. The others in order are Pennsylvania, first, 93; Ohio second, 52; Illinois and Wisconsin tied for third, each with 25 and New York fifth with 19.

More marked changes are noted in the electric steel castings producers. Pennsylvania has dropped back from first place through its decrease from a total of 31 electric steel castings plants to 30, while Ohio has gone forward to a tie for first place with a total of 30, where only 27 were shown in 1920. California has come up from fifth to second place by its increase from 11 to 19 electric foundries. Illinois and Wisconsin each report 15 shops; while New York is fourth with 10.

In Canada, Quebec is now in the lead with electric steel foundries, having 11, compared to 6 reported in 1920, while Ontario shows only 4 as compared to 9 two years ago.

The ranking order of the cities in terms of the total number of foundries shows marked changes. Chicago still is in the lead with a total of 197, compared with 194 two years ago. Detroit has advanced from fourth to second place, showing 134 shops in 1922, compared to 122 two years ago. New York is third with 129; Cleveland fourth with 117 and Philadelphia still is fifth with 97. Milwaukee also retains its relative position, sixth, although a decrease from 92 to 82 shops is reported. Boston has forged ahead to seventh place, usurping that formerly held by Pittsburgh, through its advance from 70 to 77 foundries. St. Louis now is eighth with 75 plants, while Pittsburgh has dropped back to ninth place with 70 plants.

The accompanying Table IV shows some interesting facts. This gives a list of the cities of the United States and Canada which have 15 or more foundries on Sept. 1, 1922. It shows a total of 2282 castings plants, while the previous report shows 2220, marking an increase in these principal foundry centers of 62 or 2.8 per cent over the two year period. As was noted previously, the grand total increased from 6516 to 6733, giving a gain of 217 or 3.32 per cent. In other words, the increase in the foundries in the leading centers has not been so marked as it has in the communities which previously are not rated as leading castings producers.

Table IV

Leading Foundry Centers in the United States and Canada

	Total foundries, 1922	Total foundries, 1920
Chicago	197	194
Detroit	134	122
New York	129	125
Cleveland	117	123
Philadelphia	97	100
Milwaukee	82	92
Boston	77	70
St. Louis	75	68
Pittsburgh	70	73
Cincinnati	64	61
Los Angeles	63	48
Buffalo	61	66
Toronto, Canada	55	53
Newark, N. J.	44	39
Minneapolis	43	37
San Francisco	42	42
Baltimore	39	39
Dayton	37	38
Columbus	37	37
Indianapolis	36	35
Toledo	35	38
Erie, Pa.	34	30
Rochester	33	29
Montreal, Canada	32	29
Birmingham	32	30
Denver, Colo.	32	26
Louisville, Ky.	31	31
Seattle	30	31
Canton, O.	30	29
Syracuse	28	28
Portland, Oreg.	27	26
Reading	26	26
Springfield, O.	26	26
Chattanooga	25	28
Bridgeport, Conn.	25	25
Atlanta	24	25
Grand Rapids	24	24
Kansas City	23	22
Worcester, Mass.	23	22
Providence, R. I.	22	22
Racine, Wis.	22	20
Rockford, Ill.	22	18
Hamilton, Ont.	21	19
Oakland, Cal.	21	16
Jersey City	20	23
New Haven, Conn.	18	15
Quincy, Ill.	17	17
Anniston, Ala.	17	17
Vancouver, B. C.	16	17
St. Paul	16	15
Waterbury, Conn.	16	15
Akron, O.	15	19

Constructs Reservoir To Pour Fly Wheel

By Harry W. Gilbert

To make the mold for a 31-ton fly wheel presented no unusual difficulties and with two cupolas capable of melting the iron available no trouble was anticipated on that score, however, with an equipment of two jib cranes, one 10 and one 3-ton ladle the problem resolved itself into devising some method of conveying the metal from the cupolas to the mold. We might have borrowed a 20-ton ladle from a neighboring firm, but as it would have been necessary to cut a hole near the bottom on one side and use the ladle as a reservoir we decided to build a temporary reservoir. A bottom and top plate and double row of cast iron curbing were used for this purpose.

The bottom plate was set up at a sufficient height to bring the tap hole of the reservoir above the pouring basin. The inside row of curbing was built approximately to a 6-foot diameter and about 6 feet high. The outside row was only built about 4 feet high and 8 inches distant from the inner row all the way around. The space between the two rows of curbing was filled with sand which was rammed firmly as a precaution against the iron leaking out and also as a means of preventing the heat from radiating. A top plate provided with a large hole was set on the top and long bolts engaging suitable lugs in both top and bottom plates were employed to bolt them firmly together. The bottom and inner wall of the chamber then were bricked and dried as in the case of an ordinary ladle and a 5-inch hole stopped with a plug provided as a tap

hole. With a single brick lining the reservoir had an estimated capacity of 22 tons of iron.

The wheel was gated on the spokes through upright runners connected to a circular basin built on top of the mold. Extension runners, one leading to the tap hole of the reservoir and the others to where a ladle was suspended from each crane served to convey the iron to the circular basin. The casting was satisfactory in every respect.

Develops New Cupola Charging Device

OWING to increasing labor costs British foundrymen since the war have been turning their attention to mechanical cupola charging devices. Many of them have been developed along the lines of the blast-furnace skip-hoists. However, most of the charging devices of this nature so far constructed have been for extra large cupolas owing to the difficulty of designing the apparatus at suitable cost for moderate sized furnaces where it is not possible to employ a man especially to operate the charging machine.

However, recently Thwaites Brothers, Limited, Bradford, have developed a skip-hoist type of charger suited for cupolas ranging in hourly capacity from 1½ to 15 tons. Therefore, it is seen that this machine is designed to cover a wide range of furnace sizes including the smaller as well as the larger.

The general features of this apparatus as designed for a cupola with a melting capacity of 4 to 5 tons per hour are shown in the accompanying illustration. The machine consists of a bridge which is supported by the cupola shell at its upper end and rests on a concrete foundation at the lower end. The skip bucket travels on rails on the bridge in the usual manner. The bucket is hoisted by two wire cables which are fastened to a yoke at the lower end as shown.

RELEASING HAND LEVER AT BASE OF HOIST BRINGS BUCKET TO STANDSTILL AT ANY PART OF ITS ASCENT OR DESCENT

The hoisting gear, which is a feature of this device, is electrically operated. It is carried on a platform about 6 feet above the ground and is entirely enclosed in a steel plate case as shown in the illustration. The hoist consists of an electric motor coupled to a suitable winding drum through an epicyclic gear somewhat similar to a Ford automobile transmission. The lever shown at the bottom of the hoist operates the brake bands on the epicyclic gearing, the motor being controlled by a switch. In this way a single lever controls both the upward and downward movements, the bucket descending by gravity under what is said to be satisfactory control. An automatic stop at the top prevents overwinding. If the hand lever is released the bucket comes to a standstill at any part of its ascent or descent automatically, this feature tending to prevent accidents.

For larger cupolas the device is similar except that separate charging buckets are used, these buckets being filled at any convenient point in the stockyard and brought to the bottom of the hoist by means of a small truck or industrial railway.

Safety Council Convenes

A movement for the adoption of a safe practice code for protective clothing to be worn by workmen in the iron and steel industry was begun at a meeting of the metals section of the National Safety council during the eleventh annual congress of the council in Detroit Aug. 28-Sept. 1. The officers of the section are to take up with those of the National council a suggestion for providing such a code. The suggestion came from Francis Feehan, supervising inspector, Pennsylvania state department of labor and industry, Harrisburg, who read a paper on standardizing protective clothing.

"Statements from reliable safety engineers," he said, "certify that protective clothing and appliances relating thereto have reduced accidents in the iron and steel industry in many instances more than 50 per cent." He expressed his belief that standardization would reduce costs and simplify inspection and regualtions. The day

of spectacular accident reduction in large industrial groups is practically over. Individual plants in which standard practice is introduced will still make records, but the present trend of events is toward a slow decline with fluctuations corresponding to the variation of industrial conditions."

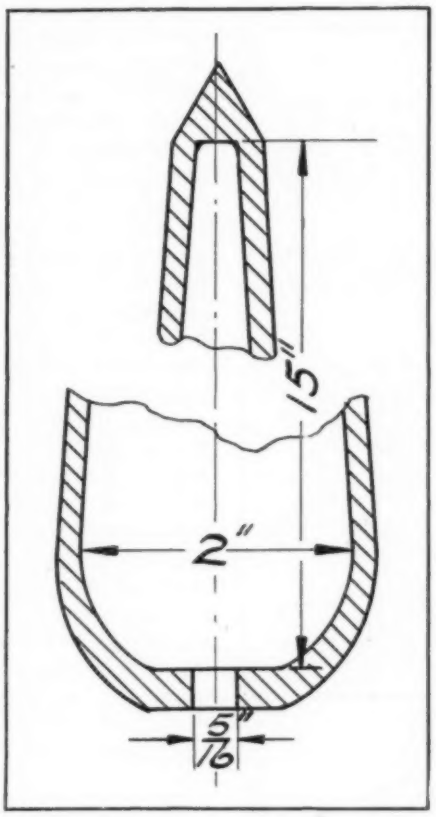
"A discussion of the relative merits of chain and cable for cranes followed the reading of a paper, "Safety in Crane Repairing," by E. E. Remington, assistant superintendent of maintenance of the Ford Motor Co. Marcus A. Dow, general safety agent of the New York Central railroad, was elected president of the National council, succeeding A. H. Young, manager of industrial relations, International Harvester Co.

Small Vent Dangerous

By Thomas Nelson

In many instances worry, needless work and expense could be eliminated in manufacturing establishments if department heads would work together toward a common end rather than according to how a certain line of action will affect their own particular section. In a recent number of THE FOUNDRY I noted a short article describing a core venting problem which reminded me of one somewhat similar caused by lack of co-operation between department heads. The foremen of the machine and pattern shops were not on speaking terms and naturally when a debatable point arose, instead of holding a consultation and arriving at a compromise, each man held rigidly to blueprint instructions with the result that occasionally jobs had to be made over on account of some practical detail overlooked by the draftsman.

The casting shown in the accompanying illustration is a case in point. It was designed to be cast hollow merely for lightening purpose. The draftsman decided that a 5/16-inch hole at the large end would be ample for cleaning out the core and one that easily could be plugged afterward. The patternmaker knew perfectly well that the foundryman could not place a satisfactory vent opening in the narrow neck, but because the blueprint called for a 5/16-inch opening in the casting, he made his corebox and pattern accordingly. The foundryman protested to the patternmaker but he stood firmly to his blueprint instructions and the castings were made. They all blew off the cores and then an investigation was held. When the machine shop man was consulted he said it was all the same to him whether the hole was 5/16 or ¾-inch, he could plug one just as easily as the other. The pattern and corebox were changed to the extent of substituting a ¾-inch neck at the large end of the casting



THE OPENING IN THE END WAS TOO SMALL FOR A VENT

and with this space available for vent the foundryman experienced no more trouble.

Care and Treatment of Pneumatic Tools

By E. J. Edwards

Careless operation, by which I mean not holding the tool down to the work, is one of the most injurious practices I have observed in the use of pneumatic tools. Where the tool is allowed to ride up and down on the shank of the chisel, the piston strikes the shoulder of the cylinder with undue force and a series of shocks of this character eventually crystallizes the structure. Broken throttle valve caps or other small parts in the handle usually are the first indications, followed by broken handles and stripped cylinder threads. The shoulder of the cylinder is not meant to intercept the blow. In normal position, the shank of the chisel should extend to a point slightly beyond the shoulder and should receive the full force of the piston blow. Operators should be instructed to hold the tools down to the work. In this manner endless trouble will be averted, the tools will retain their efficiency for a longer period and the cost of maintenance will be reduced appreciably.

It is advisable to wash pneumatic tools in kerosene oil about once a week. More frequent washing has a tendency to remove the oil film and expose the wearing surface. An occasional bath in kerosene is quite necessary to remove various forms of foreign material that accumulate in the course of operation.

Operators frequently remove the hardened steel bushing from the handle. This bushing should be screwed into the handle and left there at all times. Its purpose is to take care of the wear incident to screwing the air hose on and off the tool. Without the bushing the life of the tool is shortened to a considerable extent. Once the threads are worn or stripped it is difficult to do anything with the handle of the hammer. The blacksmith who dresses the chisels or some other responsible person, should check the chisel shanks at intervals to insure that they are not too short or badly worn.

The piston rod in a sand rammer wears more in the center than at the ends. This is due to the fact that the piston does not take the full stroke. The stroke is regulated by the operator and of course depends on the character of the job on which he is employed. On account of this condition it is quite difficult to keep the stuffing box tight. Where the rod is worn to any appreciable extent, it should be taken out and ground to the smallest size, or in other words straightened. This treatment will eliminate the leaking stuffing box to a considerable extent.

Steel Foundry Started

A plant has been established at Sherbrooke, Que., by the Manganese & Steel Foundry, Ltd., and operations have been started. The company is at present engaged in the production of castings and contemplates developing a Dominion-wide trade and proposes to establish plants in other centers. P. McCullough, formerly of the Canadian Brake Shoe Co., is president and general manager of the new company, and A. S. Bayles, formerly of the Canadian Ingersoll Rand Co., is secretary-treasurer.

Buys Indiana Plant

Buildings and grounds of the Elwood Iron Foundry, Elwood, Ind., have been sold for $4700 by Richard F. Broadbent, receiver, to Joseph G. Field, who represents Elwood capital and who will begin the operation of the plant. At a similar sale a few weeks ago the property brought $6700, but the purchasers did not close the deal.

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Shall Production Be Slackened?

SPECTACULAR and somewhat startling announcements were made recently by one of the largest employers of labor in the automobile field that his works will be closed at an early date due to the exorbitant price he is asked to pay for coal. This will throw out of employment not only the thousands of men working in the plants of the automobile manufacturer, but also more thousands of workers in shops supplying him with materials and parts. Tire manufacturers, sheet mills, forge shops and foundries will be affected. The effects of the so-called buyers strike which immediately preceded the recent depression is still in the memory of many although such things usually are forgotten quickly by the general public. The question as to the effect of the withdrawal from the fuel market of such an important interest is in the minds of many. Few if any will deliberately follow his example, but his advertised step may tend to cause a hesitance in precipitate buying. With basic industrial conditions so widely different from what they were when the depression started a similar occurrence will not follow. Money is cheap, the frozen credits of a year or two ago have been liquidated, and no great stock of manufactured goods is on hand to stand a shrinkage. Thus business will go on improving until financial stringency or an overstocked condition is developed. Higher costs while not an immediate cause of curtailment will tend toward such a condition and effort should be made by manufacturers to check the recent moves to increase production costs. A healthier state would be indicated if all industries followed the example of the automobile trade which so drastically cut prices.

Present Coke Market an Enigma

THE foundryman must consider all influences in the industrial situation before deciding on his course to pursue in purchasing coke. Undoubtedly more coal will be mined to supply the coke ovens and this will tend to lower the price of both coal and coke. In fact, the prices of these fuels already have begun to soften. How far this movement will go is doubtful for from all quarters come reports that the supplies of coke are low and foundries no longer have a stock to draw from, but will have to secure sufficient coke for their operating needs from the open market. While with the mines working the needs of the country should be kept supplied and even an accumulation be acquired, the strike of the railroad shopmen which gives no indication of settlement in the near future may hinder distribution to such an extent that coke may be difficult to obtain. The question then resolves itself into one of buying as little coke as possible and still have enough to allow operation when shipments are delayed. The foundryman who can do this successfully will make money even though paying high for coke, especially if he watches his costs and does not bid in work at too low figures. Tempered optimism should govern every activity under present conditions, as undoubtedly the trend of industrial activity will be upward for some time to come. Advance in price of all the elements involved in the production of castings has amounted to approximately 20 per cent with prospects of still further increase; a condition that should convince the foundryman that he is standing on slippery ground and should move cautiously in accepting contracts.

Trade Outlook in the Foundry Industry

COSTS of production, particularly to the manufacturer of gray iron, malleable and steel castings are mounting. Fuel, except in a few localities, is not considered to be an acute problem; but indirectly, the fuel situation of the country is preventing foundries from securing needed materials. The priority of coal shipments has erected embargoes on many lines against the shipment of any rough freight. This effectively cuts off southern iron from northern foundries, curtails the potential supply of fuel, and shuts off the transportation of molding sands. Castings demand continues strong, particularly in automotive, agricultural, domestic and sanitary lines.

Costs Advance

A rough comparison will serve to indicate why the price of castings is advancing and must continue to rise. Six months ago southern No. 2 pig iron was $15.50, Birmingham. Today it is above $28.00. A ton of iron requires approximately 200 pounds of coke to melt it. On March 15, this amount of Connellsville coke would have cost $0.47 at the ovens; today it costs $1.40. Considering a possible ½-ton of sand required per ton of iron melted, the pit price on March 15 for this quantity would have been 0.87; while with a price advance predicted for Sept. 15 of 50 cents per ton, the cost will be $1.12. An accurate cost survey of a northern gray iron foundry in the spring gave $40.00 a ton as the labor cost. With the steady advance noted in wages, a 20 per cent increase in this figure would give $48.00 a ton. The difference in these various items would give the increase in the cost of iron, $12.50; in coke, $0.93; in sand, 0.25; and in labor $8.00. Totaling these differences, the approximate increase, disregarding the minor items of supplies, etc., would be $21.18 in actual cost. Obviously this would be increased in a greater ratio in steel and malleable castings, where annealing and other elements enter and where the labor cost is higher.

Prices of Raw Material for Foundry Use

CORRECTED TO SEPT. 7

Iron		Scrap	
No. 2 Foundry, Valley	$31.50 to 34.00	Heavy melting steel, Valley	$16.75 to 17.00
No. 2 Southern, Birmingham	25.00 to 28.00	Heavy melting steel, Pitts...	18.50 to 19.00
No. 2 Foundry, Chicago	32.00	Heavy melting steel, Chicago	17.50 to 18.00
No. 2 Foundry, Philadelphia	32.26 to 35.64	Stove plate, Chicago	19.00 to 19.50
No. 2 Foundry, Buffalo	32.00 to 33.00	No. 1 machy. cast, Chicago	23.50 to 24.00
Basic, Valley	28.00 to 30.00	No. 1 cast, Philadelphia	18.00 to 20.00
Basic, Buffalo	32.00 to 34.00	No. 1 cast, Birmingham	16.00 to 16.50
Malleable, Chicago	32.00	No. 1 cast, Buffalo	19.50 to 20.00
Malleable, Buffalo	35.00 to 36.00	Car wheels, iron, Pittsburgh	21.00 to 21.50
Coke		Car wheels, iron, Chicago	22.50 to 23.00
Connellsville foundry, coke	$13.00 to 14.00	Railroad malleable, Chicago	21.50 to 22.00
Wise county foundry, coke	13.50 to 14.50	Agricultural mal., Chicago	21.50 to 22.00
		Railroad malleable, Buffalo	19.00 to 19.50

Iron Prices Soar

Shipping difficulties have introduced an artificial shortage of foundry iron, particularly in the north. Southern iron is effectually embargoed from coal hauling roads, while steel works needs, and the demands of increased production have rendered the supply from northern furnaces entirely inadequate. Some foundries, particularly in the districts devoted largely to automotive and machinery castings have only a few weeks supply, and special analysis iron is in demand to carry the miscellaneous iron and scrap which are obtainable. In Cincinnati, the gateway to the south, plants have been closed due to a shortage of metal. That the fuel situation is not directly affecting these foundries is shown by the fact that many gladly would trade coke in the yards and in transit for pig iron, could they find other foundries more fortunately situated with regard to the latter. Pig iron production fell off in August. According to *The Iron Trade Review*, the total output was 1,780,163 tons as compared to 2,403,030 tons for July. The daily average production of merchant pig iron dropped from 11,081 tons, compared to 14,250 tons per day in the previous month, registering a decrease of 3169 tons.

Castings in Demand

No decrease is noted in castings demand. Automobile foundries are working at capacity, although a reported slackening in sales of passenger cars presages slowing manufacture. The July total output of passenger cars and trucks was 244,444 compared to the June total of 289,002, according to the department of commerce. Advance estimates indicate that the August figures will closely approach June, as considerable impetus has been given by threatened coal shortage and transportation difficulties. Railway car purchases have dropped away. The August total involved only about 1600 freight car orders as against 13,700 for July. However, repair orders were heavy and the volume of business reaching foundries, particularly malleable and steel castings plants has been sufficient to maintain full time operation. Renewed buying early in September, backed by the growing car shortage seems to indicate a heavy demand for railway castings through the fall and winter. In the period from Aug. 15 to 23, the daily average surplus of 81,959 cars, a decrease of 2600 from the previous week, while the bad order rolling stock has grown rapidly. Sanitary ware demand is lighter, due to the advanced season. During July, 99,235 bath tub orders were received, compared to 128,876 in the previous month; while the requirements for lavatories, sinks, etc., showed a similar decline. Malleable operation is estimated at 60 per cent.

Brass Shops Busy

Brass foundries continue to operate at a high rate, supported by the demand from constructional and automotive lines. Prices for non-ferrous metals, based on New York quotations in the *Daily Metal Trade* of Sept. 7, follow: Casting copper, 13.40c to 13.50c; electrolytic copper, 13.80c to 13.90c; Straits tin, 32.37½c to 32.50c; lead, 5.90c; antimony, 5.50c; aluminum, No. 12 alloy, producers' price, 19.00c to 19.20c and open market, 16.00c to 16.30c. Zinc is 6.25c, E. St. Louis, Ill. The monthly average prices for August follow:

(New York Quotations)

Casting Copper	Electro. Copper	Lead	Tin Straits	Antimony	Aluminum 98-99	Zinc St. Louis
13.470	14.00	5.847	32.392	5.283	17.875	6.243

Personal

Alfred J. Lewis recently was appointed district representative with headquarters at Room 208, Fountain building, Cleveland, for the Pittsburgh Grinding Wheel Co., Rochester, Pa. Mr. Lewis has had a general technical and engineering training and has made a close study of abrasive problems. He has had over 15 years of practical experience with the Babcock & Wilcox Co., Barberton, O., the American Steel Foundries, Alliance, O., the Ferro Foundry & Machine Co. Cleveland and the Otis Steel Co., Cleveland.

Gilbert H. Johnson, of Isaac C. Johnson & Co., Spuyten Duyvil, New York, has been elected a director of the Bank of America, New York.

Edward Feast has resigned from Michigan Gray Iron Castings Co. to be foundry superintendent for the Liberty Foundry Co., Detroit.

James Wilkins has resigned his position with Lindemann Hoverson Co., Milwaukee, to become superintendent, Michigan Gray Iron Castings Co., Detroit, an automobile casting foundry.

Donald R. Simonds, formerly with the Arcade Malleable Iron Co., Worcester, Mass., is now associated with the Boston office of Rogers, Brown & Co.

John O. Cline, formerly with the Buckeye Jack Co., Alliance, O., has been appointed superintendent of the Cadillac Malleable Iron Co., Cadillac, Mich.

Frank B. Worrilow, for the past five years superintendent of the Millbury Steel Foundry Co., Millbury, Mass., has resigned to become assistant superintendent of a foundry in Pittsburgh, Pa., Sept. 18.

W. H. Ryan, for many years associated with Pratt & Letchworth Co., Buffalo, has accepted the position of superintendent of the malleable department of the Superior Steel Castings Co., Benton Harbor, Mich.

Charles A. Anderson, Jr., for the past five years in charge of the Philadelphia offices of the Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, has been promoted and transferred to the home office in the capacity of assistant sales manager.

Harry A. Wilber, secretary of the Fremont Casting Co., Inc., Worcester, Mass., is one of the incorporators of the First Massachusetts Carbon Fuel Co., Worcester, a $1,000,000 corporation to make carbon as a fuel from peat.

J. C. Peil, formerly superintendent of foundries, Maxwell Motor Co., Dayton, O., later in a like position with the Rumley Co., LaPorte, Ind., has taken an interest in the Ypsilanti Motor Castings Co., Ypsilanti, Mich., and has become superintendent of that company.

Fred W. Ramsey, who resigned as president of the Cleveland Metal Products Co., Cleveland, sometime ago to devote his time to philanthropic activities, has been elected chairman of the Cleveland Tractor Co., Cleveland. Rollin H. White continues as president of the tractor organization.

John Aman, who for many years owned and operated the Monarch Foundry Co., Detroit, a shop devoted exclusively to gas engine manifolds, disposed of his foundry interests two years ago and has recently gained control of the Liberty Foundry Co., Detroit.

A. L. Rea has been made general manager of the new plant of the Federal Radiator Co., Zanesville, O. W. H. Watt is the new superintendent of the foundry division. He formerly was assistant foundry superintendent of the American Radiator Co., Buffalo. Edward Davis will be assistant to Mr. Watt.

Announce Course in Iron and Steel

A nontechnical course in the manufacture and distribution of iron and steel has been prepared by the Industrial Association of Cleveland, under the direction of Charles M. Newcomb. The course will extend over 16 weeks, beginning Oct. 12 and will include lectures, motion pictures, plant visitations and study of text book.

The association is composed of employers and employes and has received considerable attention, affording means for the two to meet on friendly terms and discuss industrial problems. More than 300,000 men and women in Cleveland are working in or are in some way connected with the iron and steel industry and metal manufacturing trades. The enrollment will be limited; a nominal fee will be charged.

Each of the subjects covered will be discussed by a speaker chosen for his expert knowledge and ability to impart information. The outline of the course follows:

Oct. 12—"The Iron and Steel Industry in America." Name of speaker to be announced later.

Oct. 19—"Historical and Economic Background of the Subject," Herbert M. Boylston, professor of metallurgy, Case School of Applied Science.

Oct. 26—"Iron Ore, Its Mining, Transportation and Handling," H. C. Allen, general manager of mines, Ogelbay-Norton & Co., vice president of the Lake Superior Iron Ore association.

Nov. 2—"The Blast Furnace and Its Products," Ralph H. Sweetser, assistant to the vice president, blast furnace division of the American Rolling Mill Co., Columbus, O.

Nov. 9—"The Making of Bessemer Steel," Charles R. Sturdevant, American Steel & Wire Co.

Nov. 16—"The Making of Open-Hearth Steel," Willis McKee, in charge of the open-hearth and mill department of the Elyria Iron & Steel Co.

Nov. 23—"Electric Steel, the Triplex Process and Alloy Steels." Name of speaker to be announced later.

Dec. 7—"The Manufacture of Tool Steel." Name of speaker to be announced later.

Dec. 14—"The Mechanical Treatment of Steel, (a) Rolling." Name of speaker to be announced later.

Dec. 21—"The Mechanical Treatment of Steel, (b) Forging and Other processes," James H. Herron, president of the James H. Herron Co., consulting engineers.

Dec. 28—"The Manufacture of Wrought Iron Pipe," Fletcher Collins, representing the A. M. Byers Co.

Jan. 4—"The Manufacture of Castings," Harry A. Schwartz, manager of research, The National Malleable Castings Co.

Jan. 12—"The Industrial Heat Treatment of Steel," W. H. Eisenman, secretary of the American Society for Steel Treating.

Jan. 18—"The Metallography of Iron and Steel." Herbert M. Boylston, Case School of Applied Science.

Jan. 25—"The Marketing and Use of Iron and Steel," C. J. Stark, editor of THE IRON TRADE REVIEW.

Feb. 1—"Future Possibilities of the Industry." Speaker to be announced later.

Teaches Foundry Practice

Pratt Institute, Brooklyn, N. Y., offers in the evening classes its school of science and technology a course in foundry practice. This is divided into two sections of 12 weeks each, the first being the elements of iron-foundry practice. This course was designed primarily for young foundry workers such as molders, machinists, patternmakers and draftsmen who might be qualified for higher positions if they had a wider

knowledge of the industry. The course covers making molds from both simple and intricate patterns, the use of molding machines and the elements of cupola furnace operation. Talks and demonstrations are also included in the course. The second section, on cupola operation is particularly designed for melters, foremen and molders who wish practical and technical instruction in the most advanced methods of operating a cupola furnace. This course, gives special attention to lining materials, chemical constituents of cast iron, foundry irons, mixtures for different classes of castings, mixing by analysis, and the utilization of steel scrap. These points are discussed thoroughly and explained in the class room, then given practical application in the school foundry.

Dean of New England Foundrymen Dead

Theodore H. Colvin died at his home in Providence R. I., Aug. 13, at the age of 76. Born in Plainfield, Conn., in 1846, Mr. Colvin learned the molder's trade and moved to Providence in 1872. Here he founded the partnership foundry of G. & T. H. Colvin. In 1876 Mr. Colvin bought the interest of his partner and carried on the business as its sole owner under the name of Theodore H. Colvin, until 1896, when it was incorporated as the Colvin Foundry Co. He acted as president of the new firm until Jan. 1917, when he retired, turning over the business to his two sons, Charles T. and Clarence H. Colvin.

Mr. Colvin always took a keen interest in advancing the foundry industry early associating himself with the New England Foundrymen's association. He was a charter member of the American Foundrymen's association, taking part in its organization at the first meeting held in Philadelphia.

Prominent Philadelphia Manufacturer Dies

Coleman Sellers Jr., president of William Sellers & Co., Inc., Philadelphia, machinery manufacturers died Aug. 15, in his seventieth year after an illness of several months. His connection with the Sellers organization began in 1873 immediately after his graduation from the University of Pennsylvania. After serving a practical course in the shops for several years, he took a position in the drafting room of which he soon became the head. He was appointed assistant manager in 1887, becoming also a director of the company. He was elected engineer in 1902 and president in May, 1905, which office he held continuously until his death. Mr. Sellers was long active in the affairs of the Franklin Institute, of which he was vice president. He was a member of the board of commissioners of navigation of Pennsylvania, to which he was appointed in 1907. He took special interest in the work of the American Philosophical society, the American Society of Mechanical Engineers, the American Society of Naval Architects and Marine Engineers, and the Engineers Club of Philadelphia, of which he was a founder. He was president of the Philadelphia chamber of commerce from 1909 to 1913. He served as chairman of a Philadelphia draft

THEODORE H. COLVIN

board during the world war and with such fidelity and assiduity that it seriously impaired his health and contributed to his subsequent illness and death.

Study Sulphur in Coke

According to a recent bulletin of the United States bureau of mines, study of the desulphurization of coke was begun July 1 at the Pittsburgh station. This is a practical follow-up of the theoretical study of the oxidation iron sulphate in the coke and the subsequent removal of the free sulphur formed by this oxidation. Literature on this subject is being reviewed. Many patents were taken out in the years 1850 to 1870 and few since. Roasting and steaming were favorite methods. In this connection, methods for converting sulphur in coke into FeS form are being sought. A process based on such method would hold back sulphur that might ordinarily be evolved, then this sulphur could later be removed by oxidation together with much additional sulphur. It seems that Fe_2O_4 mixed with coal being coked decreases the sulphur in solid solution. The work is being undertaken by Dr. A. R. Powell, physical organic chemist, and John H. Thompson, research fellow of the Carnegie Institute of Technology, Pittsburgh.

Book Review

The Work and Position of the Metallurgical Chemist, by Sir Robert A. Hadfield; cloth, 98 pages 6 x 9¾ inches; published by Charles Griffin & Co. Ltd., 12 Exeter street, Strand, London, and for sale by THE FOUNDRY, price $4 net.

This book is the publication of an address by Sir Robert A. Hadfield delivered before the Sheffield Association of Metallurgists and Metallurgical Chemists, Oct. 24, 1921. Two of the early sections of the book are devoted to the position which Sheffield holds in the metallurgical world and the work accomplished by the industry particularly during the war.

Beginning with Section 4 the author introduces his discussion of the metallurgical chemist. Speaking of a chemist he says, "The chemist's work is arduous; in making his analyses he is often performing numberless operations, all of them requiring great care and the slightest failure of any one of which will completely vitiate the final result. There can be no cooking of figures; accuracy must reign supreme." The various headings appearing in the discussion are: The chemical societies and the development of chemistry, including a list of chemists of the early days and a modern list of metallurgical chemists; training and work of the chemical engineer; the influence of the chemical engineer; the influence of chemistry in the war; German chemists; the indebtedness of the metallurgists to science; Japanese Research Institute of Iron and Steel; metallurgical literature; and finally metallurgy and poetry in which is discussed the relation which exists betwen the two.

A few chapters are devoted to the author's research work and his contributions to science, including the investigation and application of manganese steel and his work in connection with low hysteresis steel used chiefly in the construction of transformers and other electrical apparatus. The last few chapters are rather miscellaneous in nature discussing federation of engineering interests, including the United Engineering council, the Federation of Engineering institutions and the engineers clubs in London and New York. Electrical power is given some attention with mention made of

the possible development of Victoria Falls in South Africa. The potential power from this source is compared with that available at Niagara Falls. Rapid motion picture photography and American railroads and their long trains are discussed. In closing, Sir Robert Hadfield expresses an appreciation of ancient research workers.

Start Nonferrous Shop

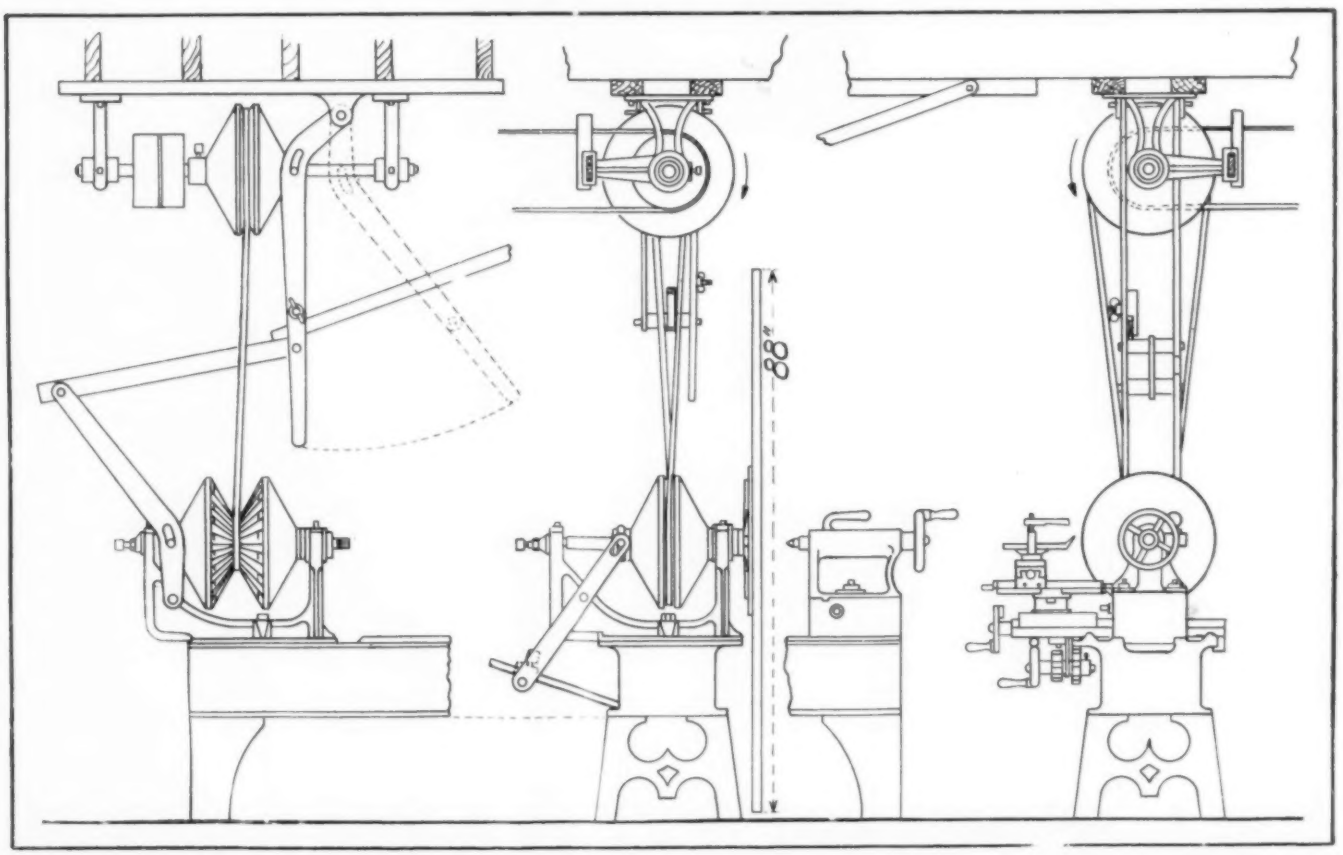
Operations recently have begun by the Florence Brass Works, Florence, Mass., manufacturer of brass, bronze and aluminum castings. T. D. Miller, president and treasurer of the new enterprise, formerly was connected for a period of 7 years with the Try-Me Mfg. Co., Westfield, Mass.

Develops Driving Pulley for Pattern Lathe

Designed especially to meet patternmaker's requirements, the lathe shown in the accompanying illustration has been placed on the market by the Buffalo Gear & Pattern Works, 16 to 20 Elk street, Buffalo, N. Y. In addition to a great saving of time on ordinary work and absolute mechanical accuracy, it is claimed that the lathe may be employed to handle jobs that could not be turned on the ordinary lathe, such as broken surfaces, ellipses and narrow, inside work. Variation of speed is effected through intersecting cones as shown in the illustration, by which the diameter may be changed from 6 to 20 inches at any time while the machine is running. The two cones are connected to arms controlled by one lever so that as one closes the other opens, thus maintaining an even tension on the belt. The cones are made of light cast-iron shells filled with light wooden ribs set at a 60-degree angle. The triangular or round belt, made to fit the groove, is not injured by the wood strips.

The lathe bed is 9 feet 10 inches long, 12 inches deep. The lathe will swing 32 inches over the bed, 24 inches over the carriage and 6 feet between centers. The compound rest, 18 inches long, is surmounted by a cross compound slide 7 x 4 inches carrying the tool post. With this arrangement all lateral, transverse and bevel cuts can be taken at the one setting. For long tapers the tail center can be shifted to either side by an adjusting screw. The head stock rests on a 24-inch round base and is held by a center bolt, which can be released and tightened to hold the head in any desired position.

Where the work is too large to swing over the bed, the levels are removed from the head stock, the center bolt slackened and the head turned to swing parallel with the bed, thus limiting the swing only by the floor and ceiling. A short pair of levers with cross-buckles between the ends and a rod or pipe braced against the bed, served to hold the head cone in any desired position. The counter cone then is moved until the belt becomes tight and then is clamped by a thumb screw to the supporting brace. A lock pin holds the head stock in the correct position. The compound rest is transferred to a column similar to that on the cross slide and mounted on a three-legged horse. A cleat on the floor against which the front legs abutt, serves to bring the compound rest parallel with the swing of the lathe and also serves as a gage for either parallel or taper cuts. For example, with the width across the front of the legs known, it is a simple calculation to determine what thickness pieces are required between either leg and the cleat to insure a corresponding taper cut on the work. For standard angles, long wedges may be used. The operator sits on the horse while manipulating the feed screws. The swing of the lathe is in line with the bed and therefore all possibilities of vibration are eliminated.



OPPOSING, INTERSECTING CONES FURNISH A READY MEANS OF CHANGING SPEEDS WHILE THE MACHINE IS RUNNING. THE HEAD STOCK MAY BE SWUNG AROUND TO HANDLE JOBS ONLY LIMITED IN DIAMETER BY THE FLOOR AND CEILING

Slack Hits Equipment Sales

Difficulties Confronting Foundrymen Incident to Operating Conditions Defer Interest In Purchases of Machinery or Supplies—Expansion Awaits Brighter Outlook

LITTLE encouragement is offered to manufacturers of foundry equipment by the volume of sales during the early weeks of September. Operating difficulties render the foundryman unwilling to consider new machinery until assured of his supplies of coke and pig iron. However, much business is in sight, as shown by current inquiries and projected expansions, when operations are more firmly established. Recent sales of sand blast equipment by the Pangborn Corp., Hagerstown, Md., include machinery for the Crucible Steel Casting Co., Cleveland; the Fox Furnace Co., Elyria; the George H. Smith Steel Castings Co., Milwaukee; and the International Harvester Co., Springfield, O. The Mayor Fuel Saving Furnace Co., Cleveland, is installing two batteries of double end core ovens at the plant of James B. Clow & Sons, Coshocton, O.

Crane Purchases Active in the East

ALTHOUGH no price revisions in foundry equipment have as yet been noted, an advance in some items is being considered and early action is expected. Quotations on iron and steel are steadily increasing, and although the recent widespread advances in labor in the iron and steel industry has little effected the foundry equipment industry where common labor is relatively little used, the tendency in wages of skilled employes is upward, and may materialize in the near future.

The Farrell Foundry & Machine Co., Ansonia, Conn., which recently closed on several hundred tons of steel for a new foundry to replace the one badly damaged by fire a month or two ago, is a buyer of equipment at this time. One or two other new projects also are receiving consideration, including a foundry in Providence, R. I., for which 300 tons of steel have just recently been closed. The Frick Co., Waynesboro, Pa., has completed all conveying equipment buying having just purchased a 3-ton cage controlled monorail system from the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Previously, the Frick Co. closed on a 25-ton electric crane with the same company. The M. W. Kellogg Co., Jersey City, N. J., which has been a large buyer of cranes during the past couple of months, now is inquiring for a 5-ton overhead crane, floor-controlled, for a foundry. The American Car & Foundry Co. has closed on eight 2 and 3-ton electric hoists, this business also going to the Shepard company. Some foundry work is also said to be contemplated by the Pennsylvania railroad, which has just come into the market for 12 large electric overhead cranes. This shipment will be bought through Philadelphia, and while it has not been stated where it is going, it is known that the Pennsylvania contemplates large improvements at Altoona, Pitcairn, and at a point near Harrisburg, Pa. Reed Prentice Co., Worcester, and the General Electric Co., Schenectady, are recent purchasers of sand blast equipment from the Pangborn Corp., Hagerstown, Md. The latter is for the Baltimore plant.

Chicago Demand Slackens

RETARDED demand for foundry equipment and supplies is evident to sellers in the Chicago market at present. Difficulties experienced in obtaining deliveries of raw material and uncertainty as to future prices of pig iron have caused some melters to be backward about obligating themselves into the future and this is assigned as a reason for their lessened interest in equipment. Practically no new cupolas have been sold in this district during the past fortnight and the demand for ladles, both large and small, is much less. While this condition exists some interesting selling has been done and the market is far from as quiet as during the early summer. The Ford Motor Co., Detroit, has ordered five additional electric jolt molding machines from Henry E. Pridmore, Chicago, and other scattered orders for molding machines also have been placed. The Howard Stove Co., Beaver Falls., has bought from the Whiting Corp. four tumbling barrels of various sizes and the Eagle Foundry & Machine Co., Jamestown, N. Y., has taken one tumbler from the same seller. The American Car & Foundry Co. has purchased a 20-ton transfer table for its Detroit plant from the Whiting Corp., which has also sold several cranes as follows: 10-ton hand power crane for the Boston & Albany railroad, at Boston; two 125-ton electric traveling cranes 92½ foot span for the Chicago, Burlington & Quincy railroad; 15-ton electric traveling crane for the Kewanee Boiler Co. That much attention is being paid to sand conditioning in the present effort for efficient foundry operation is indicated by the enlarged demand for sand mixing machinery. The National Engineering Co., Chicago, recently shipped a large sized mixer to a Chester, Pa., foundry and others to Rochester, N. Y., Cedar Rapids, Iowa, Cleveland and Cincinnati, in addition to other orders about to be closed. Recent sales of sand blast equipment by the Pangborn Corp., Hagerstown, Md., include installations for the Muncie Malleable Foundry Co., Muncie, Ind., and the Hubbard Steel Foundry Co., East Chicago, Ill. The International Harvester Co. has purchased a crane from the Northern Engineering Works, Detroit.

Decrease Noted in Pittsburgh District

SELLERS of foundry equipment in the Pittsburgh district noticed a falling off in orders during the latter part of August which extended over into the fore part of September. However, inquiries in hand point toward the resumption of fairly sizable buying during September. One or two foundry equipment lists are current, each including practically everything, cupolas, core ovens, sand mixing and handling machinery, molding machines, grinders, etc., together with a quantity of smaller equipment such as flasks and riddles. Orders for flasks and riddles have been fairly numerous during the past several weeks, indicating a resumption on the part of jobbing foundries. The settlement of the coal strike aided in this respect since casting makers catering to coal mine supply companies directly or indirectly have had their businesses increased with the resumption of numerous union coal mines. While molding machine inquiries since Sept. 1 have been quite numerous, sales have been few. Included in the list of contracts taken by the Herman Pneumatic Machine Co. late in August or early in September, are the following: Large and small molding machines for the American Locomotive Works, Schenectady, N. Y., and two large ones for the same company's Chester, Pa., plant; four small machines for the Chapman Valve Co., Indian Orchard, Mass.; three large machines for the American Radiator Co., Buffalo, and two small ones for the Washington Iron Works, Seattle, Wash., together with one or two single installations elsewhere. The Stroh Steel-Hardening Process Co., Pittsburgh, is a prospective purchaser

of equipment for its foundry addition at Ridge avenue and Chateau street. Hoists and crane inquiries from foundries are few and far between although occasionally a single installation is noted. The Warner Elevator Co., Cincinnati, closed on a 5-ton Shaw crane and the Hope Engineering & Supply Co., Mt. Vernon, O., awarded its crane contract although the successful bidder's name is withheld. The United Engineering & Foundry Co., Pittsburgh, is about to purchase three cranes for a new plant of the National Enameling & Stamping Co., St. Louis, and cranes shortly will be purchased by the Otis Steel Co., the Wierton Steel Co., the Carnegie Steel Co., and other large interests in this territory. The Morrow Mfg. Co., Wellston, O., closed on two small hoists with the Shepard Electric Crane & Hoist Co. Kelly & Jones Co., Greensburg, Pa., Ridgeway Dyamo & Engine Co., Ridgeway, Pa. and T. B. Wood's Sons Co., Chambersburg, Pa., recently have purchased sand blast equipment from the Pangborn Corp., Hagerstown, Md.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The plant of the Novelty Iron Works, Sterling, Ill., recently was damaged by fire.

Contracts have been let by the Atlas Copper & Brass Mfg. Co., 3740 High street, Chicago, for the erection of a plant building, 50 x 123 feet.

John Freitas, Irvington, Cal., is reported planning the erection of an addition to his aluminum foundry.

The Elgin Stove & Oven Co., Elgin, Ill., recently increased its capital stock from $125,000 to $250,000.

The Hartford Foundry, Hartford City, Ind., plans improvements and enlargements to its plant at an estimated cost of $15,000.

The Barberton Machine Shop & Foundry Co., Barberton, O., has taken out a permit to erect a plant building at an estimated cost of $25,000.

Capitalized at $100,000 the Merchantville Aluminum Brass Works, Camden, N. J., recently was incorporated by Anton Krazalkavics, Peter Bernacki and Andrew Raroba.

Erection of a foundry building is being planned by the Stroh Steel-Hardening Process Co., Westinghouse building, Pittsburgh. Plans of the company have not been made public.

Capitalized at $200,000 the Bridgeport Bronze Co., Bridgeport, Conn., recently was incorporated by J. Grout, 886 Main street, Bridgeport, and several others.

The Alco Foundry & Machinery Co., Hamden, O., has been incorporated with $50,000 capital stock by M. C. Abele, John J. Abele, Walter A. Lausch, Adolph Roether and H. M. Stroh.

A brass foundry and machine shop, costing about $20,000, is being erected by the Nekoosa Motor & Machine Co., Nekoosa, Wis. This plant will replace one damaged by fire several weeks ago.

Contracts have been let by the Sheboygan Foundry Co., Sheboygan, Wis., maker of gray iron castings, for the erection of a pattern shop, storage vault, grinding and cleaning room and office building.

Capitalized at $100,000 the Seaboard Brass & Copper Co., 805 Continental building, Baltimore, recently was incorporated with a capital stock of $100,000 by Herbert Langrall, Edwin M. Talbot and Harvey H. Wilson.

The Morristown Electric Steel Foundry Co., Morristown, N. J., recently was incorporated with a capital stock of $125,000, by J. Lovel Paulmier, Samuel B. Illingworth and Richard H. Eurich.

Preparatory to construction of a new plant at Hammond, Ind., the Damascus Crucible Steel Castings Co., Pittsburgh, has bought a site of 10 acres along the Nickel Plate railroad. Plans now call for the immediate erection of the plant buildings.

Jerome and Frank Chopiska and J. V. Nirgo, formerly of the Chopa Piston Ring Co., Auburn, Ind., have organized the La Crosse Motors Equipment Co., La Crosse, Wis., to manufacture a special type of piston ring, etc. The company has opened a plant at 227-231 North Third street, La Crosse.

Stephen & Wolff, Inc., Buchanan and Loomis streets, Rockford, Ill., has been incorporated with a capital stock of $25,000, to operate a machine shop and foundry, by W. A. Stephen, F. J. Wolff, and others. The company is represented by David D. Madden, Ashton building, Rockford.

The Aetna Aluminum & Brass Casting Co., 834-836 West Forty-ninth street, Chicago, recently was incorporated with $6000 capital stock by F. A. B. Smith, William F. Bodong and Joseph R. Koehler. The company is represented by Campbell & Fischer, 1542 First National Bank building, Chicago.

Buildings and grounds of the Elwood Iron Foundry, Elwood, Ind., have been sold for $4700 by Richard F. Broadbent, receiver, to Joseph G. Field, who represents Elwood capital and who will restart operations in the plant. At a similar sale a few weeks ago the property brought $6700 but the purchasers did not close the deal.

Plans have been prepared for the erection of an addition to the plant of the Birmingham Stove & Range Co., Birmingham, Ala., which will add 50 men to the roll and will provide for the manufacture of gas stoves and ranges in the Birmingham district. The company now is melting 12 tons of iron daily. B. H. Hartsfield is vice president and general manager of the company.

A plant has been established at Sherbrooke, Que., by the Manganese & Steel Foundry, Ltd., and operations have been started. The company, at present, is engaged in the production of castings and contemplates developing a Dominion-wide trade, establishing plants in other centers. P. McCullough, formerly of the Canadian Brake Shoe Co., is president and general manager of the new company, and A. S. Bayes, formerly of the Canadian Ingersoll-Rand Co., is secretary-treasurer.

Work will be started at once on the erection of the first unit of the proposed plant of the McWane Cast Iron Pipe Co., North Birmingham, Ala. A site of 30 acres has been purchased. J. R. McWane, president of the company, has announced he expects to have the first unit in operation in March, giving employment to upwards of 150 men and producing small sized pipe, ranging from 1½ to 6-inch. The company is operating under lease at the plant of the Southern Pipe & Foundry Co. Mr. McWane is a member of the executive board of the American Cast Iron Pipe Co. and for a long time was president.

Cast iron soil pipe and fittings and other castings, are being manufactured by the McChesney Foundry & Mfg. Co., which recently was incorporated with $35,000 capital stock to operate a foundry at 3004 Madera street, El Paso, Tex. This is said to be the only plant of its kind within 1000 miles of El Paso. In addition to patented floor drains and other pipe fittings, hot water heating plants, grates, sash weights, coal chutes and other castings are manufactured. L. P. McChesney is president of the company and was one of the incorporators with W. S. Dobie and Judge S. J. Isaacs. J. O. Crawford is sales manager for the company.

New Trade Publicaitons

RESISTANCE THERMOMETER—The Brown Instrument Co., Philadelphia, has issued a 24-page catalog giving complete descriptions and photographs of resistance thermometers. Sixteen reasons are given why it is said these thermometers are particularly advantageous for measuring temperatures between minus 300 degrees Fahr. and plus 1000 degrees Fahr. Some of the claims made are resistance thermometers have no cold junctions which must be considered in thermo-electric pyrometers; the resistance of the bridge or current circuits in multiple is high, between 450 and 550 ohms; hence, change in current due to the temperature coefficient of the battery used is almost impossible; the current required to operate the instrument is so slight that four dry cells, producing six volts will last four months before renewal; a 6-volt storage battery may be used if preferred as a source of electromotive force. Two types of recording resistance thermometers are shown. The circular chart type will keep a record of the temperature for 24 hours. This type is equipped with a clock. The other is the continuous chart model making it possible to keep a continuous record. It may be regulated so as to make two records side by side on the same chart. Various switches and humidity bulbs also are shown and described. In addition complete specifications and various charts and diagrams for wiring the thermometers are presented.

ELECTRIC RESISTOR—F. J. Ryan & Co., Philadelphia, have published a 3-page folder fully explaining the use of the electric resistor in producing electric heat.

MONEL METAL—The International Nickel Co., New York City, have issued a 15-page illustrated booklet on monel metal. A thorough account is given of its various desirable properties. Some of the subjects considered are its appearance, corrosion resistance, strength under normal conditions, strength at high temperatures, impact resistance, resistance to alternating stress, toughness, etc. A list of the various forms in which monel metal is available also is included.